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ORTHOPEDIC SURGERY.

MANUAL

OF

ORTHOPEDIC SURGERY,

BEING

A DISSERTATION

WHICH OBTAINED

THE BOYLSTON PRIZE FOR 1844,

ON THE FOLLOWING QUESTION:

"IN WHAT CASES AND TO WHAT EXTENT IS THE DIVISION OF MUSCLES, TENDONS, OR OTHER PARTS PROPER FOR THE RELIEF OF DEFORMITY OR LAMENESS?"

BY

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"Eripiunt omnes * * * * * sine vulnere nervos."

Ovid. Remed. Amoris, V. 147.

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The following votes were adopted by the Boylston Committee in 1826 : —

1. That the Board do not consider themselves as approving the doctrines contained in any of the dissertations to which the premium may be awarded.

2. That in case of the publication of a successful dissertation, the author be considered as bound to print the above vote in connection with it.

PREFACE.

The works I have consulted in writing the following Dissertation, are chiefly those of Guerin, Bonnet, Velpeau, Phillips, Duval and Little; especially the brochures of the former, who has been for some time, the leading French orthopedist.

The writings of M. Guerin may be fairly criticised both for the wordiness and obscurity of their style, and for their unnecessary bulk; but it does not appear that we have any right to question the accuracy of their statements. On the contrary, we may infer from the late report of the committee appointed by the Academy of Medicine to investigate this point, that there is no ground for supposing the evidence in any way warped or misrepresented.

It is possible that M. Guerin has availed himself of the suggestions of previous writers; that in common with other specialists, he has over-estimated the importance and the efficacy of his art; that he has been in-

discreet in its application, and that "the division of forty-two tendons, muscles, &c., upon the same subject," was an audacious undertaking, rather than "a remarkable achievement;" but it should not be forgotten that the scientific acquirements and practical skill of this orthopedist are undisputed; that he is the author of valuable discoveries, confirmed as such by the Academy of Medicine, and that, much as he may be indebted to previous writers, the account has at least been squared, by the compensating drafts of those who have followed him.

The article upon Strabismus, the first of this dissertation, is somewhat disproportioned in length to the subsequent chapters. The materials were originally collected without the intention of incorporating them into this work. In allowing them to retain their present extent, I was decided mainly by the fact, that no complete treatise upon this subject had appeared upon this side of the water. The same is true of the chapter on Stammering, the operation for which is now a matter of history, a curious instance of the indiscreet zeal of some of the noted continental surgeons.

DISSERTATION.

It is obviously difficult to procure the evidence upon which a direct answer to the question proposed by the Committee should be based. The subject is comparatively new, and demands farther investigation. Among its different departments, it is easy to show why the present operation for stammering should be proscribed; but it is not easy to indicate the cases which require a section of the muscles of the back, or of the tendons of the hands and fingers. These questions can be decided only by a careful analysis of a large number of cases, with reference to the pathological conditions of the subject, and the results of differ-

ent methods of treatment. They have not been settled by those most conversant with this branch of Surgery, and demand opportunities which are probably afforded only by the larger European institutions.

It is believed that the general intention of the committee will be fulfilled, by an attempt to cover the ground now occupied by *Orthopedic Surgery.*

STRABISMUS.

But few years have elapsed since the operation for Strabismus was announced, under circumstances of considerable interest. It proposed the relief of an obvious and frequent deformity, with little pain or hazard to the patient, and, at the same time, promised to the surgeon the notoriety which attends a new and successful operation. Thus recommended, it rapidly gained ground, and was performed many hundred times in Europe and in this country, not only by competent surgeons, but by operators, who either were not qualified to investigate the lesion in a scientific view, or whose interest it was to furnish incorrect or partial statements of their results.

Of the memoirs upon this subject, many offer a limited series of observations, inadequate for pur-

poses of induction; others are manifestly inexact; and a still greater number are controversial essays; adapted to advance a particular method, or its advocate, at the expense of others. The following details have been drawn from the few more authentic papers which have recently appeared.

ANATOMICAL CONSIDERATIONS.

The ball of the eye offers little worthy to be noted in connection with this operation. *The Sclerotic* is a dense, resisting coat, which may be freely denuded with probe pointed instruments without risk of perforation, or other mechanical injury; neither does it readily become inflamed.

Vessels. A case of alarming hemorrhage from the operation, has been published in the English journals, and seems to have been the result of a decided hemorrhagic diathesis in the patient, a child of eleven years of age. The hemorrhage was arrested after the transfusion of several ounces of blood from the arm of a healthy adult. In a normal condition of the circulating system, the arteries of the orbit are not of a size to occasion danger or inconvenience from hemorrhage, while the veins in the region of the ethmoid bone are easily avoided.

Nerves. It seems superfluous to suggest that the optic nerve, inserted somewhat nearer the inner than the outer angle of the eye, may be wounded by a deep and careless dissection upon

the nasal aspect of the globe. An instance of its actual division in this way, has, however, been reported. The internal, superior, and inferior recti muscles, and the inferior oblique, are supplied by different branches of the motor communis or third pair; while the superior oblique and external rectus muscle, each appropriating a separate nerve, are supplied by the fourth and sixth pairs respectively. No ill effect results from the section of the branches of these nerves at the point where the muscle is usually divided.

Muscles. The four recti and two oblique muscles of the globe, are the chief agents in the production of Strabismus. The vivid red of the muscular fibre can, in most cases, be detected at the bottom of the incision, while the fan-like expansion of its tendinous insertions is often invisible among the surrounding tissues. The anterior tendinous fibres of the four recti muscles, are inserted at the distance of two or three lines from the cornea, while other fibres attach themselves to the sclerotic a line or two behind; so that the whole somewhat resembles in form the adhering tail of a leech, to which it has been aptly compared.

The superior oblique muscle springs from the fibrous sheath of the optic nerve, traverses the pulley at the upper and internal angle of the orbit, and turning backwards and outwards, joins the sclerotic beneath the superior rectus muscle and a little behind its insertion.

The inferior oblique leaves the superior maxil-

lary bone in the neighborhood of the lachrymal sac, and retreating a little, winds outwards round the globe of the eye, to be inserted upon its upper and external surface.

Aponeuroses. Much attention has been directed of late years to this part of the anatomy of the eye, especially by Guerin, Velpeau and Bonnet (de Lyons). Their researches have demonstrated two principal fibrous expansions.

The first, which lines the periosteum of the orbit, retreats upon the optic nerve behind, and being continued forward upon the eye-lids to their free edges, envelopes in this manner the whole contents of the bony orbit.

The second is in contact with the sclerotic, which it covers and protects as it were, from the surrounding adipose matter. *In front*, it is reflected upon the internal surface of the conjunctiva, which it lines to its insertion at the edge of the lids, where it unites with the aponeurosis of the bony orbit. *Behind*, it is prolonged upon the optic nerve, where it again joins the orbitar aponeurosis, with which it forms a shut sac, from which the globe of the eye is excluded, much as the intestine is excluded from the cavity of the peritoneum. This sac is traversed by the muscles, each of which, as it enters the cavity, borrows from it a fibrous envelope, which is reinserted at its point of exit. A tube is thus formed, which gives passage to the muscle without affecting the integrity of the sac.

It will be remembered that these aponeuroses are

chiefly noted for the rôle which different writers have assigned them in ocular deformity, and the impediment they are supposed to offer to the various steps of the operation. They have also a certain influence in the normal movements of the eye, to be hereafter examined.

MOVEMENTS OF THE EYE.

Muscles. The action of the *recti muscles* upon the globe is easily understood; and I am not aware of any difference of opinion upon this point. If a single muscle acts, the pupil turns towards it, upon a vertical or horizontal line. If two juxtaposed muscles contract, the pupil moves obliquely in the diagonal of the forces thus applied. Less is known of the action of the *oblique muscles*, and while eminent writers have cited a variety of evidence in support of their different theories upon this point, the contradictory character of their opinions leads us to doubt their accuracy. That certain forms of strabismus are said to require a division of these muscles, is a sufficient apology for a somewhat detailed examination of the movements attributed to them.

The superior oblique draws the point of its sclerotic insertion towards the cartilaginous pulley, while the action of the *inferior oblique* is direct.

Cruvelhier ascribes to the superior oblique a simple action of rotation of the ocular globe upon its antero-posterior diameter, the eye being at the same

time slightly carried forward in the orbit. To the inferior oblique, he attributes a similar rotation in an opposite direction.

Velpeau supposes that the superior oblique carries the eye inwards and downwards; while at other times it rather aids the external rectus and inferior oblique in external strabismus.

Charles Bell has termed the superior oblique a respiratory nerve, from its supposed influence in raising the eye in the expression of certain emotions; as in sighing. In experiments upon the dead subject, he found the eye turned downward and outward by traction upon this muscle. In supposing that in life it antagonizes the inferior oblique muscle, he suggests that its involuntary relaxation in certain expressions gives an opportunity for the action of the latter muscle, which then rolls the pupil upwards.

A later and more plausible theory of *Guerin*,[1] and *Skolaski*,[2] is supported by a number of pathological observations, and can easily be tested.

Examine the eyes of a person at a convenient distance, and draw imaginary horizontal lines through spots upon the conjunctiva. Let the head now be laterally inclined towards the shoulder, and it will be seen that the imaginary lines continue horizontal and parallel with the floor or ceiling of the apartment, although their position in relation to the lids be changed; in other words, the eye tends, by

[1] Communication á l'Institut. Aout 1840.

[2] Mem. Addressé á la Societé de Médec. de Gand. 1840.

a rotation upon its antero-posterior axis, to retain its relative vertical position. Whatever be the utility of such an involuntary movement, it must be allowed that it belongs to the oblique muscles, as supposed by these physiologists; although it attributes to the inferior oblique branch of the third pair of nerves, the power of producing involuntary action.

Aponeuroses. The aponeuroses are said to possess a certain influence upon the movements of the eye. In the lateral movements of the ball, the angles of the lids enlarge at the approach of the pupil; and certain writers have supposed this action to be due to a simple traction of that portion of the aponeurosis of the globe, which is prolonged to the free edge of the lids. A permanent displacement of the ball would then occasion permanent traction of the lids.

But this explanation is open to objection. Were the harmony of action between the lids and the globe due to a purely mechanical influence of the fibrous tissues, it should follow, that when the pupil is buried beneath the roof of the orbit, both lids should be equally elevated by their respective aponeuroses. The pupil rolls thus upwards in the involuntary motions described by Charles Bell, a fact verified by placing the finger upon the lids while they are forcibly shut. It is then observed that while the pupil rises *involuntarily*, the upper eye-lid falls; an antagonizing action directly opposed to the upward traction of the ball upon the upper lid. The lower lid seems to be more directly attached

to the globe. It follows the elevated pupil, and never antagonizes the superior lid so well as when the eye is rolled up beneath the orbit.

The importance of these aponeuroses in their healthy condition seems to have been exaggerated. It is, however, easy to suppose, that bands of condensed cellular tissue might attach themselves to various parts of the orbit and globe, and tend to impede the free motions of the eye, especially were the globe retained by muscular contraction or otherwise, in a given position, for a length of time.

CAUSES OF STRABISMUS.

Strabismus is characterized by a want of harmony in the action of the eyes. The internal recti muscles alone possess the power of producing a voluntary strabismus; which is then an exaggeration of the convergent action which directs both eyes towards a single object.

The duration of strabismus varies with its exciting causes.

One variety of the deformity depends upon a transient spasmodic action of the muscles. It is observed in many individuals while talking; and is sometimes of momentary duration. Different exciting causes of this variety have been noticed. A moment of anger; an elevated temperature; a current of air upon the forehead; or any cause which acts upon the nervous system. Temporary strabismus has been known to precede the cata-

menial discharge, and has been observed in infants immediately before the development of dentition.

Another variety accompanies apoplexy, or other grave lesions of the brain; while a third class results from tumors in the soft, or bony tissues of the orbit; in which cases the deformity is symptomatic, and directs attention to the more serious affection.

There are, however, certain forms of strabismus, less immediately connected with important organic lesion, which depend upon the physiological conditions of the surrounding tissues. In these cases the affection may originate in the muscles, or the nerves which supply them; or result from a derangement in that part of the machinery of the eye, which is directly concerned in the sense of vision.

1. *Muscular Contraction.* While the operation was yet new in England, Sir Astley Cooper remarked to the writer of this paper, that he believed it impossible that it should generally succeed; that while the correction of the deformity of a limb, was mainly due to its treatment after the operation, the nature of the eye would forbid the application of an efficient orthopedic apparatus. Strabismus has been elsewhere termed the club-foot of the eye; but the condition of the parts is not such as to warrant the comparison. If a club-foot be examined, the retraction is found to be firm and permanent. The foot yields but little to the application of a considerable force. But if in a common case of ocular deformity the

sound eye be closed, it will be found at the end of a certain time, that the pupil of the affected eye emerges from the angle of the lids, and advances to take its place in the centre of the orbit, while the sound eye is in its turn everted. In the former case the muscle has lost its power of elongation; it often undergoes a transformation which assimilates its substance to that of a fibrous tissue. In the eye, on the other hand, the muscle retains its anatomical structure, such a transformation being very rare. In four hundred and twenty-two cases operated upon by Phillips, the fibrous transformation occurred three times; while in more than five hundred patients, two cases only were observed of fatty transformation.

What then is the condition of the muscle in the majority of cases? Accumulated testimony seems to warrant the assertion, that the muscle is in a condition of permanent but active contraction; an explanation more readily received, when it is remembered that a great number of cases are sudden in their access, and date from the convulsions of infancy.

2. *Optic Strabismus* is a term applied by M. Guerin to the deviation which sometimes follows distortion of the pupil, or spots upon the cornea in the axis of vision. As the rays of light are thus hindered from reaching the retina in a direct line, the eye deviates from a central position, in such a way as to present a transparent portion of the cornea, or the pupillary aperture, directly to the object. Although such cases are not uncommon, every surgeon has

observed central opacities of the cornea without ocular deviation. M. Guerin supposes that this sort of distortion forbids operation. On the other hand, M. Velpeau affirms, that the lesion presents no greater tendency to reappear in these cases than in others; and in balancing the amount of vision acquired by the deformity, against the personal attractions lost by it, he considerately submits the question to the vanity of the patient. Surgeons having thus acquired the power of correcting strabismus at the expense of the sight, it obviously remained for some ingenious oculist to undo the operation by reversing the process; to restore the vision by producing a squint. This has been done by M. Cunier. He proposes[1] in cases of central opacity of the cornea, to divide one or more muscles of the eye, so as to determine a strabismus, which shall put the pupil in relation with that portion of the cornea which remains transparent, and thus permit the light to arrive at the bottom of the eye.

3. *Strabismus from Muscular Paralysis.* The affection which gives rise to this form of strabismus, has received much attention of late years, from ophthalmic surgeons, and especially from M. Sichel. Its effect is analogous to the distortion observed in the extremities, when the paralysis of certain muscles is followed by the unopposed retraction of their antagonists. It occurs in certain cases of a paralytic affection of one or several of the muscular fasciculi.

[1] Lettre a l' Acad. des Sciences. 1841.

If the external rectus be alone involved, the eye deviates to the side of the nose. If the internal rectus be affected, external strabismus is the result; and the eye turns up or down, as the inferior or superior straight muscles cease to act upon it.

An affection of the third pair of nerves sometimes occasions paralysis of the three muscles which it supplies, and the external rectus alone retains its power.

Distortion of this sort, is distinguished from common strabismus, by the inability of the patient to direct the eye towards the affected side, when the other eye is closed. The deviation is sometimes slight, and the eye merely refuses to follow its companion in certain directions, while otherwise it moves freely. It is less easy to distinguish a paralysis of several muscles, from that form of strabismus which results from adhesion of the surrounding tissues, and immobility of the eyeball. A degree of motion, however, exists in most cases, and were there none, the former might be distinguished by its capability of passive or forced motion, which the fixed immobility of the other forbids.

These varieties of strabismus have been subjected to operation. It is, however, evident that remedies should be directed to the original lesion, so long as they promise a chance of relief. If the case assume a chronic form beyond aid from remedial agents, an operation may be resorted to, with a view of restoring the eye to the centre of the lids. It is sometimes accompanied with advantage

to the sight, but is more frequently an operation '*de complaisance*.'

Paralysis of the oblique muscles is more difficult of diagnosis. Two cases, probably of this affection, reported by M. Skolaski,[1] seem to confirm the supposition already alluded to, that these muscles exercise an action of rotation upon the eyeball. In both these interesting cases, the eye refused to imitate the rotatory motion of its fellow, when the head was inclined towards the shoulder, and in this position diplopy ensued. The images were superposed, and mutually receded in a vertical direction, as the head was inclined that of the stationary eye being always below.

The various duties assigned by different observers to these muscles, have been enumerated at some length, in another part of this paper; and it has been seen that the most contradictory opinions have been entertained of their real purpose. It cannot, therefore, be shown what variety of distortion would result from their permanent contraction. In fact, they have often been divided for strabismus; but the results of the few trustworthy observations upon this point are so widely opposed, that their section must be regarded, at present, as purely experimental.

4. *Strabismus from Amaurosis.* Functional, or other lesion of the optic nerve, has been considered both as a cause and an effect of ocular dis-

1 Longet. Anat. et Phys. du système nerveux. Paris, 1842. T. ii. p. 396. (*See page 8th.*)

tortion. It is undoubtedly true that amaurotic eyes are not exempt from the various distortions which affect these organs. If amaurosis is a cause of strabismus, restored vision will probably rectify the deviation. The effect of the operation upon amaurosis, will be again adverted to.

DOUBLE STRABISMUS.

In most cases of simple strabismus, if the patient be directed to regard a distant object, he does so with the sound eye, while the affected eye squints. The sight of the deviating organ is often imperfect. It is not uncommon to meet with patients who have acquired a habit of using the sound eye for more remote objects, while the squinting and often near-sighted eye is reserved for reading, and viewing objects close at hand; and a singular effect is produced by their ability to advance either pupil at will. But it sometimes happens, that both eyes present a slight deviation. In such cases, the operation should be confined to that which presents the greatest distortion. A month should be allowed to elapse, before operating upon the second; during which time, in a majority of cases, the movements of the two eyes become parallel.

Velpeau allows it to be difficult to distinguish cases of really double strabismus, from those which are so only in appearance, and which demand a single operation to correct an apparent double deformity. M. Phillips operates upon both organs,

only when the deviation in the two eyes is uniform; but then only at an interval of a month or more.

ANATOMICAL PECULIARITIES.

Adhesions of the Globe give rise to permanent strabismus, distinguished by its incapability of passive or forced motion. Such cases result from wounds and deep-seated inflammation of the orbit. Velpeau alludes to cases not referable to such conditions, in which the muscle adhered to the sclerotic as far as the posterior part of the eye. The operation requires extended dissection, and is liable to be followed by re-adhesion. Successful results have, nevertheless, been reported by Velpeau and others.

Triple Insertion. The internal and superior recti muscles are, in rare instances, divided into two or three fasciculi, at their then fanlike insertions, either of which may aid in producing a deviation.

Fibrous and fatty Transformations of the muscles are rare, and have been elsewhere alluded to.

AGE.

Neither infancy nor old age have been exempted from this oft repeated operation. In young infants, the deformity sometimes disappears spontaneously, while old people rarely care to be relieved of it. After the age of three or four years, the chances of success are greater in proportion to the youth of the patient. M. Velpeau asserts, that

the tissues require a more extended division in old people.

OPERATION.

Though definitely indicated by Stromeyer, in 1838, and performed upon the dead body by that surgeon, the operation for Strabismus was first applied to the living subject in modern times, by Dieffenbach, the 26th October, 1839.

It is probable that a similar operation was practised many years ago. The following curious advertisement of an English oculist, named Taylor, who lived in the last century, is to be found in the *Mercure de France*, *année* 1737, *juin*, *p.* 1180. "Doctor Taylor, Oculist of the King of Great Britain, has recently arrived at the *Hotel de Londres*, *rue Dauphine*, *Paris*, where he proposes to stay till the beginning of July, after which he will leave for Spain. He begs us to publish the discoveries he has made to restore squinting eyes by a rapid operation, almost without pain, and without fear of any accident."

[1] M. Cunier refers to this singular phrase in the dissertation of Verheyden, in 1767, "Strabones permultos ferro sanatos apud Anglicos vidi."

Whatever be inferred from these passages, the operation was unknown to surgeons at large, till late years.

[1] Re suppl. aux. Ann. d'Oculist. Fev. 20, 1841.

M. Carron du Villards pretends to have thought of it in 1838.

Dr. Ingalls, of Boston, Mass., is said[1] to have suggested it as far back as 1812–13.

Pauli, a surgeon of Landau, in 1839, was only prevented from attempting it by the indocility of his patient. But the first authentic operations upon the dead and living subject, belong to the surgeons of Hanover and Berlin.

A few months sufficed to introduce this surgical novelty into England and France. I was present in Sept. 1840, at some of the earliest experiments made in London. The simplicity and safety of the operation soon became known, and the new ground was at once occupied by a host of explorers striving to identify themselves with its success. All were armed with peculiar and indispensible instruments, with curious hooks and complicated scissors; with knives studiously fashioned to differ from each other. The method continually varied; and there were few surgeons who had not an operation of their own, distinguished by their name.

The general principles of most of these different methods, are the same; and I propose to examine them under the three following heads.

1. Those which resemble the operation of Stromeyer and Dieffenbach, in which the conjunctiva is first divided.

2. Those in which all the tissues are divided at once; as in the method of Velpeau.

[1] Medical Examiner, Feb. 1841.

3. The Subconjunctival method of Guerin.

In every method, the aim of the operation is the division of the muscle, and it is of little real importance whether it be effected in one way or another. But there is hardly a surgeon or an oculist who has not suggested some superfluous modification or complication of this simple manœuvre; and within a week I have observed in one of the journals, the re-invention of an instrument contrived some two years since. In the words of Mr. Liston, "All this is for the use of those gentlemen practising surgery, who are deficient in dexterity, and for the benefit of the cutlers." A somewhat tedious examination of the more important methods, if it serve no other purpose, may tend to show that there is little new to be contrived, either in the instruments or manual of this frequent operation.

For greater convenience, the operation is, in general, described with reference to convergent strabismus of the right eye.

Operation of Stromeyer. The sound eye being covered, the patient is directed to turn the affected eye outward. A small double hook is implanted in the conjunctiva at the internal part of the globe, and confided to an aid. The fold of conjunctiva is then raised with forceps near this point, and divided vertically with a cataract knife; after which the aid draws the eye outward, while the surgeon passes a small curved sound underneath the muscle, and divides it with the knife or curved scissors.

It should be remembered, that in operating upon

the dead subject, Stromeyer was not compelled to confine the lids.

Dieffenbach's Method is similar, but characterized by a greater complication of aids and instruments. The instruments are, the elevator of Pellier for the upper, and a double blunt hook with a long slender handle, for the lower lid. Two slender hooks to pierce and raise the fold of conjunctiva; scissors curved on the flat, to divide the conjunctiva and the muscle. A blunt hook to insinuate beneath the muscle, and finally, in refractory patients, a double short pronged hook, to pierce the sclerotic and confine the eye. Two assistants in general suffice. The patient is seated opposite the light, the head confined upon the chest of an aid. The surgeon sits in front of the patient, without excluding the light, and passing the elevator beneath the upper lid, transfers it to his aid. The double hook depresses the lower lid, and is held by the second aid, who kneels. The fold of conjunctiva is now suspended between the two small hooks; the first, at the inner angle, being confided to the first aid, while the second, near the cornea, is retained by the operator in his left hand. The fold is snipped with curved scissors, and the muscle exposed by dissection. The surgeon then abandons the scissors, introduces the blunt hook beneath the muscle, and, as a final step, divides it with the scissors.

In some of his earlier operations, Dieffenbach excised a portion of the tendinous extremity of the divided muscle, but subsequently renounced this process.

The Operation of Phillips, a pupil of Dieffenbach, is nearly identical with this.

Guthrie's Method. In the operations which I saw performed by Mr. Guthrie in Sept. 1840, the manual resembled that of Stromeyer. The lids being confined by instruments, or by the finger of the operator and that of an aid, the sclerotic was transfixed by a double hook, and the ball everted. The conjunctiva being then raised upon a hook and opened, a slight dissection exposed the muscle. A curved director was now passed beneath the muscle, and served to guide a short, pointed, curved bistoury to divide it.

Methods of Ferral and Lucas. These differ little from that of Dieffenbach. In the former, the forceps are substituted for one of the hooks of the conjunctiva, and angular for curved scissors.

Liston's Method. With a view of dispensing with one of his aids, this surgeon proposes to fix the eye and raise the conjunctival fold by a pair of spring toothed forceps, which, once attached to the conjunctiva near the inner angle, are left to themselves, and by their weight confine the lower lid.

The Methods of Roux and of Sedillot resemble that of Guthrie, in the use of the curved director. To fix the globe, M. Sedillot employs a hook with three branches, each furnished with a small sphere like a shot, at the distance of a line from its point, to prevent it from too deeply penetrating the sclerotic.

Baudens' Method. The lids being fixed as in

Dieffenbach's operation, the surgeon transfixes with a strong, single hook, both the conjunctiva and the muscular attachment. The eye is then drawn outwards, and the muscle rises in a plait or fold. Under this he inserts M. Baudens' knife and divides the mucous coat together with part of the muscle. The remainder of the muscle is raised with a blunt hook, edged upon its lesser curve, which thus severs its fibres. M. Baudens removes the tendinous insertion, and also trims the conjunctival edges, with a view to relieve the wound of filaments which might impede its union.

The knife of M. Baudens (fig. 4) is about an inch in length, and a quarter of an inch wide at the base, and pointed. It is curved on the edge to about a quarter of a circle. It is also slightly curved upon the flat, and the point is thus directed away from the globe of the eye, while the wedge shape of the blade enables it to cut its way out in traversing its length. It is evident that a different curve is required, for each eye.

Method of Amussat. This differs little from those already cited, except in the blunt hook inserted beneath the muscle. M. Amussat has contrived an instrument consisting of two hooks lying side by side, and so adapted to each other, as to resemble a single one. These hooks are introduced between the muscle and the eye, opened, and the muscular fibres divided between them. M. Phillips asserts that the instrument was previously invented and rejected by Dieffenbach.

Finally, *M. Gairal* has proposed a hook armed with a button and bent at right angles; the distance from the elbow to the button being four lines. This serves to designate the position of the tendon in measuring the distance between its insertion and the edge of the cornea. Introduced beneath the muscle, the arm of the instrument is sufficiently long to embrace the fibres in all their width.

2. OPERATION IN WHICH ALL THE TISSUES ARE DIVIDED AT ONCE.

First Method of Velpeau. 1. The lids being held apart by instruments, a double hook is plunged in the sclerotic near the cornea, and the eye drawn outward.

2. A strong single hook is thrust under the muscle near the angle, and a fold thus raised.

3. With a small curved knife the entire fold is divided; consisting of the muscular fibres, cellular tissue, and the conjunctiva.

M. Andrieux proposes to give the hook an edge upon its lesser curve, which would then cut its way out.

Second Method of Velpeau. The lids are separated by a self-adjusting speculum termed a *blephareirgon* (fig. 13), invented in England and modified by M. Velpeau. With a strong pair of toothed forceps, the surgeon seizes the insertion of the tendon and everts the eye. With a similar pair which he afterwards abandons to an aid, he

grasps the muscle and conjunctiva at the angle. He then divides the muscle and surrounding tissues near its middle, with a pair of curved or straight scissors, the blunt points of which are repeatedly passed backwards and forwards upon the sclerotic, to plough up any accidental undivided fibres. A last stroke of the scissors excises the tendinous insertion, and its conjunctival covering, yet retained by the first pair of forceps.

This operation, which I have repeatedly seen performed by M. Velpeau, involves a free division of the tissues surrounding the retracted fibres.

The teeth of forceps intended to grasp the tissues exterior to the sclerotic, should be slightly recurved, that their convexity may repel this membrane when pressed against it, while their approaching extremities pierce the tissues in immediate contact with it.

M. Velpeau sometimes uses but one pair of forceps, and the operation then resembles that proposed by M. Daviers (d'Angers.)

A sponge is often required during the operation, and a pair of slide forceps has been contrived to hold it, attached to the handle either of the knives or scissors, (fig. 4).

3. SUBCONJUNCTIVAL METHOD.

Applying to the eye, the principles of subcutaneous operations, M. Guerin has adopted a process

which, though somewhat complicated, deserves attention.

The instruments in this operation are peculiar. A spear resembling a saddler's awl, whose greatest width is rather less than a quarter of an inch, an inch in length, and slightly curved upon the flat, that it may follow the ocular sphere, serves to pierce the mucous envelope.

The shaft of the knife employed, is first bent to a right angle, and then rebent to its original direction at the interval of about an inch (fig. 6, 7). Two elbows are thus formed, to one of which is attached a strong handle, while the blade at the other is an inch in length, and slightly convex on the edge. They allow the handle of the instrument to lie flat upon the cheek or forehead of the patient, while the blade is beneath the muscle to be divided, and perpendicular to its fibres. In other words, the bend in the shank of the knife, adapts it to the depression of the eye beneath the orbitar ridge.

The manual is as follows, the patient lies upon a table, the head supported by a pillow, while the lids are confined by any of the common means. A double hook is plunged in the sclerotic, near the cornea, and when the eye is everted, abandoned to an aid. A fold of conjunctiva is now raised near the insertion of the tendon, with a hook, which the operator holds in his left hand, while with his right, the spear is carefully plunged to the depth of half an inch along the inner surface of the muscle, and

then withdrawn. The operator then directs the blunted point of the knife towards the occiput, enters it at the aperture, and engages it beneath the muscle. As a second step, he depresses the handle upon the cheek, so that the blade lies across and beneath the muscle, while the shank of the knife, between its elbows, is engaged in the small conjunctival aperture. By a third manœuvre, he turns towards the muscle the edge, which previously looked towards the occiput. Extracting the now useless hook from the conjunctiva, and taking in his left hand the sclerotic hook from the aid who has held it, he gently draws the eye outward, while with his right, he severs the muscle by a sawing motion of the knife. Its division is attended with a slight noise, audible at some distance. The surface of the eye is then explored, by ploughing, as it were, its surface with the blunted point of the knife, and, thus any remaining fibres are divided. The instrument is withdrawn with a movement, the reverse of that by which it entered.

Such is the operation in which I have often assisted M. Guerin. With a little manual dexterity, it is quite simple, and seldom occupies more than half a minute in its execution.

APPRECIATION OF THE DIFFERENT METHODS.

Before examining the details of the operation, it will be well to determine, as nearly as possible, the

conditions most important to its success. At Paris, the early operations of MM. Roux, Sedillot, and others were eminently unsuccessful. Of ten cases reported by M. Velpeau, three only were radically cured of the deformity. When the method of Dieffenbach was better understood, results were more favorable. Phillips, a pupil of this surgeon, operating in the presence of Amussat, Baudens, and Lucien Boyer, obtained from them the avowal, "that they at last understood why, until then, they had only met with failure; and they, with reason, referred the constant success of this operation, to M. Phillips' use of the blunt hook of Dieffenbach, in searching for the contracted muscle."

It has been observed from what has preceded, that the chief use of the blunt hook, (*crochet mousse*, fig. 5,) is in searching for such undivided filaments, as may have escaped the first division of the muscle. Its blunt point is repeatedly passed backwards and forwards, up and down, in a direction perpendicular to that of the muscular fibres; and being urged against the sclerotic, it seldom fails to insinuate itself beneath the tissues nearest in contact with this membrane, which are then easily raised and divided.

To a similar cause does M. Velpeau attribute his want of success, as will be inferred from his remarks upon the operation of M. Phillips. "Seeing M. Phillips operate upon the dead subject, I at once understood that, in imitating him, we could hope to succeed, where we had completely failed. In fact,

observing that he divided the conjunctiva and all the tissues contained in the orbit, over a third at least of the surface of the globe of the eye, I perceived that among my patients, numerous layers destroyed by M. Phillips, must have remained in place. For my part, I had not dared, at first, so largely to denude the sclerotic, and to perform a dissection at once so extended and so profound, in the orbit. I avoided it with extreme care, and aimed especially to confine the division of the conjunctiva and the other tissues, to a very small extent. The fear of seeing a phlegmonous inflammation establish itself in the orbit, did not permit me to go farther.

"M. Phillips having affirmed that the consequence of such extensive denudations, of a division of the tissues, which had alarmed me upon the living subject, were extremely simple, and involved no serious accident; and having soon after demonstrated the truth of his assertions in operating upon patients, our convictions were changed, and the question soon assumed a new phase."

A complete division of the parts is then the great aim of the operation; and it is safe to assert, that so long as any contracted filaments remain undivided, the success of the operation will be compromised. A partial section may in some instances suffice; but at present, it is impossible to distinguish such cases, or to designate in the orbit the particular fibres concerned in the deformity.

In dissecting perpendicularly down upon the sclerotic, we endanger its integrity. It is therefore

necessary to interpose something between this membrane and the parts immediately in contact with it, by which they may be at once discovered and commanded.

Now it is of little consequence whether this be effected by any of the numerous blunt hooks of different operators, by the probe pointed blade of curved or straight scissors, or by the rounded tip of M. Guerin's knife. The type and element of the instrument employed, is the blunted hook "*crochet mousse*," of Dieffenbach; split longitudinally, and, attached to the crossed legs of the common forceps, it becomes the "*crochet a écartement*" of Dieffenbach and Amussat; furnished with an edge upon its inner curvature, it is the "*crochet bistouri*" of Baudens; and armed with a point, it is curved to the "*crochet tranchant*" of M. Andrieux, the "*myotome a double courbure*" of Baudens, and the common curved bistoury of other surgeons. It is also recognised in the blade of common curved scissors, which, in the hands of M. Velpeau, are straight; while with M. Guerin, a knife attached to a crooked handle, answers the purpose.

This step of the operation, I consider essential. The manual varies with the taste and habits of different surgeons; but in every method, there is a blunted point thrust between the sclerotic and the last undivided fibres. These being once discovered and elevated, are easily cut; if raised upon the blunt hook, by a knife or scissors, or by the edge of the hook itself, if it have one. They are equally

well divided between the arms of the "*crochet*" of Amussat, by the twin blade of scissors, and finally, in the subcutaneous operation, by the edge of the tenotome.

The other parts of the operation may be considered in their order. The upper lid is, in general, better held by the common elevators, than by the finger of an assistant, though the latter is often sufficient. As in other operations upon the eye, the finger should be covered with cotton cloth, which absorbs the secretions, and maintains a better hold upon the lid.

The lower lid may be confined by the forefinger of the operator's left hand, or by a double hook held by an aid. The forceps of M. Liston, attached to the conjunctiva, are painful, and should only be employed when other assistance is not at hand.

Snowden's *blephareirgon* appears to offer the most effectual and simple means of fixing the lids. The metallic band attached to it by Charriere, is unnecessary and inconvenient. The pain it occasions is slight, and the instrument makers are in the habit of applying it to their own eye, to show its efficiency. It might be rendered still less painful, by a thread confining the arms, so as to prevent their diverging beyond a certain point.

In most methods, the globe is commanded by a small double hook, which penetrates the sclerotic. It should be fixed by a sudden stroke, as in entering a cataract needle. In case of failure with it, it is better to allow the wounded eye a short repose, as

it often takes on a convulsive action, and is difficult to manage. This hook offers several advantages. While it controls the eye, it enables the surgeon to extend or relax the contracted tissue, as he secures and divides it. In the method of Dieffenbach, the eye is less securely held by a flap of conjunctiva.

The conjunctiva may be raised by hooks or toothed forceps; hooks being less painful; forceps more secure. If the conjunctiva be alone transfixed, one or two hooks may be used, at the taste or discretion of the operator; but when all the tissues are to be included in the fold, two forceps are evidently more effectual, though M. Velpeau occasionally employs but one.

The incision of the conjunctiva, when near the cornea, is less liable to be followed by gaping of the lids and depression of the caruncula, than when near the angle of the eye. Though prolonged upward, it should terminate as near as possible to the lower edge of the muscle. The division of the aponeuroses downward, tends to induce a fall of the lower lid, and a consequent enlargement of the palpebral aperture.

The length of the incision varies in different methods. While M. Phillips denudes a third or more of the ocular circumference, M. Guerin insists upon the advantage of a simple puncture of a size to admit the instrument. The truth lies between these extremes, and it may be affirmed that an incision of about half an inch in length, suffices

in most cases for convenience of manipulation, and exposes the tissues to be divided. Its length necessarily varies, and in general increases with the degree of the deviation.

The cellular tissue once divided, and the red substance of the muscle brought into view, or its position exposed, its fibres are raised by an instrument passed beneath it, in the manner before indicated. Premising that the blunt hook requires least dexterity, we may leave the instrument to be employed to the option of the surgeon.

It is during this dissection, that the sponge is required; and is most convenient when attached to the handle of the cutting instrument.

With the self-adjusting speculum, the operation of M. Velpeau, which embraces at once the tissue to be divided, is rapid and simple. The use of toothed forceps is perhaps more painful than that of single hooks, but the whole method is more expeditious. I have repeatedly seen children undergo the operation without manifesting pain.

The removal of the end of the divided tendon is of doubtful efficacy. Adopted and rejected by Dieffenbach, it is now practised by Velpeau, and by Phillips, while it is not essential to success. It is affirmed by these operators, that in precluding the possibility of union by first intention, the excision of the tendon reduces the chance of a return of the deformity. Phillips asserts that it never produces accident, is not painful, and diminishes the quantity of exuberant granulations.

The subconjunctival method of M. Guerin has been much decried. Its results, of which I have seen many, have appeared to me quite as successful as those of other methods, although I have no statistics upon this point. The manual dexterity requisite for its performance, has prevented its general adoption, and has probably interfered with its success in other hands than those of its inventor. Nevertheless, it has often proved efficient among skilful operators. It may be mentioned that Dr. Cabot of Boston, obtained excellent results from this method in Yucatan. The sclerotic surface should be carefully explored for undivided fibres, while the globe is rolled inward with the sclerotic hook, and the fibres thus relaxed. When the knife penetrates beneath them, they are extended across its edge, and severed. This method is often followed by much ecchymosis, which is afterwards absorbed. On the other hand, the free incision of the common method, is soon occupied by a bunch of fungous granulations, from which the narrow puncture of Guerin's operation is exempted.

The matter may be thus summed up.

1. The retracted filaments are to be completely divided.

2. They are best detected with a blunt hook, or analogous instrument, insinuated beneath them.

3. The other steps of the operation, are dictated by the inclination or habits of the surgeon.

4. The simplest method is that of Velpeau.

SUBSEQUENT TREATMENT.

It will be readily conceived, that the treatment should bear some proportion to the extent of the incision and of the inflammation. In many cases, the patient continues his ordinary avocations without inconvenience; while in some rare instances, a violent inflammatory action ensues. In general, compresses wet with cool water suffice as an immediate application to the eye. In two days, warm emollient lotions may be substituted, and at the end of three or four days, a few drops of some mild astringent collyrium may be instilled day and night into the angle. Attention being paid to cleanliness, it is rare that more violent remedies are called for, and the organ, if carefully watched, may be sometimes left to itself.

If the inflammation tends to gain the cornea, leeches, or a cathartic are indicated; in short, ordinary remedies are to be proportioned to the violence of the symptoms. Sometimes a few hanging filaments of the conjunctiva serve to keep up irritation, and require excision.

Exuberant Granulations. A few days after the operation, if the incision has been large, the mucous membrane presents a number of small elevated papules, somewhat resembling bubbles of air. Insensibly increasing in size, if kept wet with cold compresses, they unite, become red and gorged with blood, and tend to excite a suppurative action of the adjacent surfaces. If the cold application be

now discontinued, the excrescence becomes rounded, smooth, shining, of a pearly color, and finally pediculated at base, when it may be snipped off without inconvenience.

When not treated by wet compresses, the granulations sometimes refuse to unite. Then they require to be excised separately, often with considerable hemorrhage, and are liable to be reproduced.

Cauterization, more painful and prolonged, is sometimes followed by cicatrices, with more or less retraction of the tissues.

THE DEFORMITY AFTER OPERATION WITH ITS SUBSEQUENT TREATMENT.

In a large proportion of cases, when the operation is well performed, the deviation is at once corrected; and though the eye may be unable to move in the direction of the divided muscle, the pupil assumes a position in the centre of the palpebral aperture. But this is not a constant nor always a permanent result.

In certain cases, the strabismus though less marked, is still perceptible. The sclerotic has been laid bare in the region of the retracted muscle, but the eye still deviates in that direction, and farther treatment is required to correct the deformity. Various methods have been devised for this purpose.

Division of other Muscles. It has been shown

that the division of the oblique muscles, is uncertain in its results.

Phillips divides the superior oblique, when with strabismus, the cornea is convex, and the eye salient and near-sighted. M. Velpeau has never divided it, and states that he knows no authentic and conclusive fact in favor of its section.

Equally experimental is the division of certain fibres of the neighboring recti muscles. M. Velpeau proposes to sever the inner fibres of the superior or inferior straight muscles, in convergent strabismus, and cites successful cases of these supplementary sections. It should be remembered, that while it multiplies chances of success, a free dissection exposes the patient to a variety of serious accidents. It is not unfrequently followed by exophthalmy, divergent strabismus, or fixed adhesion of the globe, and is for this reason rarely justifiable.

Loop of Thread. Dieffenbach seizes with forceps, a fold of conjunctiva, with its subjacent cellular and fibrous tissues, and passes through it a thread, which is subsequently made fast to the nose, brow, or ear of the patient. The eye is thus retained in a normal position during four or five days, at the end of which time the thread cuts its way out. This method is, for obvious reasons, difficult of application.

Compression. The convexity of the cornea affords a point of resistance, by which the ball may be in some sort fixed. The lids should be closed,

and a small, soft, globular compress placed at the angle from which the pupil is to be expelled. It is retained in place by a bandage around the head, which is made to exert a slight degree of compression at that point.

It should be mentioned that an unskilful application of this bandage in the service of M. Velpeau, was followed by phlegmonous erysipelas and destruction of the eye.

Spectacles. An advantageous method frequently employed by M. Guerin, consists of glasses, upon which paper is pasted, so as to obstruct vision, except at a point distant from the divided muscle. The pupil seeks the light, and the eye is thus kept in a favorable position.

It often suffices to cover the sound eye, and thus force the patient to exercise the other.

Lastly, a slight deviation not unfrequently disappears, without care on the part of the surgeon.

In another class of operated patients, the deviation, corrected at the time, tends to return, at an interval of from one to four weeks after the operation. The same methods are here advisable; especially that of bandaging the sound eye, and the use of covered glasses, or a bit of paste-board bridging across the orbit, and permitting vision only at the point required.

A Second Operation. If the wound has healed, it becomes a question if a second operation is indicated. For results of such cases, the reader is referred to the numerous papers of writers upon the

subject, each of whom emulates the other in successful operations upon the uncured patients of rival surgeons.

When none of the accidents to be hereafter mentioned, have followed a first operation, it is probable that no ill effect will result from its repetition; and it is better worth trying, when there is a chance that a previous operation was incomplete.

BAD RESULTS OF THE OPERATION.

Among the bad effects of a large division of the tissues, are the following:

Strabismus in a direction opposite to that of the original deformity. It demands the reverse of the treatment before indicated for a partial correction of the deviation. A compensating operation upon the contracting muscle has also been resorted to; which, while it may relieve the deformity, tends to abridge the lateral motions of the eye.

Exophthalmy. The ocular globe, deprived of a considerable portion of its muscular and tendinous ties, advances in the socket, either upon its antero-posterior axis, or with a lateral inclination. An unsightly deformity is thus produced, which is beyond the aid of art. In certain cases, when slight, and when it occurs immediately after the operation, it subsequently disappears.

Depression of the Caruncula often accompanies the last deformity, and more frequently exists alone. It is less liable to occur when the incision is made

near the cornea, than when at the angle. It is irremediable.

Gaping of the Lids sometimes occurs when the dissection is extensive. Phillips pretends to avoid this accident in many cases, by prolonging the conjunctival incision downwards, no farther than the centre of the muscle.

If the falling of the lower lid be considerable, the deformity can only be remedied by a corresponding modification of the other eye. For this purpose the mucous coat is seized by two hooks, near the insertions of the inferior straight muscle, and incised. The unsupported lid then falls, and the similarity of the eyes renders the deformity less obvious.

Immobility of the Globe. When a single muscle has been divided, the movements of the eye, impeded at first, tend to reëstablish themselves at a subsequent period. If two muscles are divided, it is probable that the movements will be less completely restored; and when the denudation is considerable, the eye inclines to contract firm adhesions to the surrounding tissues, which terminate in an incapability of motion, more or less complete, with or without strabismus. It is analogous to that produced by deep-seated inflammation, which has been before described.

Diplopy. Double vision not unfrequently follows the operation, and disappears in most cases, in three weeks or a month, provided the pupils assume a normal position.

CICATRIZATION OF PARTS AFTER THE OPERATION.

Until recently, little has been established upon this point. From the comparatively few authentic recorded observations, the following principles are drawn: —

1. If any undivided fibres retain the muscle in place, the severed ends are apt to reunite.

2. If completely divided, the posterior portion retracts, and in rare cases is inserted, fleshy, into the sclerotic, at a point remote from its original insertion.

3. It more commonly contracts tendinous adhesions with the sclerotic, near the extremity of its transverse diameter, and becomes united to the anterior divided portion, by fibrous prolongations, which are firmly attached to the globe.

DIMNESS OF VISION.

Dimness of Vision is a frequent companion of strabismus, and has been considered its effect.

It is certain, that in the common form of strabismus, when the disabled eye is brought into use, it acquires, in a large majority of cases, a new and often complete power of vision. This improvement is sometimes immediate, and sometimes gradual.

The enfeebled sensibility of the retina, is occasionally so considerable, as to have been mistaken for amaurosis. It is not, however, a contra-indica-

tion of the operation, as it results in a great number of cases from the deformity.

MYOPY.

Internal Movements of the Eye. It is evident that the internal relations of the different parts of the eye must be changed, in order to obtain successively, a correct image of a near, and of a distant object. This alteration is difficult to appreciate, and theories upon the subject have not been wanting. The convexity of the cornea has been supposed to vary; the humors to change their form; the crystalline, its figure, and more recently, its position; and perilenticular canals have been demonstrated,[1] which, with that of Petit, serve as safety valves for the temporary escape of the fluids compressed by the movements of the lens. If this action is obscure, its immediate cause is much more so, and is not clearly shown to exist either in the oblique or the recti muscles exclusively, as different writers have suggested.

In the experiments of M. Bonnet,[2] upon the eye of an albino rabbit, a distinct image of a distant window was obtained upon the retina. The eye was then laterally compressed, and while the first image was obscured, that of a neighbor-

1 By Jacobson of Copenhagen.

2 A. Bonnet. Traité des Sect. Tendin. et Musc. p. 207. Paris. 1843.

ing lamp became distinct. The experiment being repeated, it was inferred that lateral compression of the eye, placed it in conditions favorable to the perception of near objects; and it seemed probable that the position of the oblique muscles in the human eye, best adapted them thus to modify the organ.

Myopy with Strabismus. If this be true, it will be readily conceived that an exaggerated contraction of the straight muscles, also compressing the ocular globe in their position as tangents to its circumference, would diminish its capacity for viewing distant objects, and induce a state of myopy, or near-sightedness. This theory is confirmed by the fact, which is I believe established, that the form of the lesion which accompanies strabismus, disappears in a majority of cases after the operation.

Myopy without Strabismus. Attention has been of late directed to the section of different muscles, in the common form of myopy, without strabismus; but the results of these experiments are wholly unsatisfactory. MM. Guerin and Cunier have reported cases of relief, after section of the external and internal rectus. M. Bonnet claims similar results from the section of the inferior oblique;[1] and hence infers, that a section of either of these three muscles exercises a certain influence upon the vision. He prefers the inferior oblique, as being easiest of access. In his method, it is reached by plunging

[1] Op. cit. p. 231.

a short, pointed tenotome through the lower lid, at a point just above the centre of the edge of the bony orbit. The knife is carried backwards and inwards, nearly to the ethmoid, the edge being directed towards the nose. The handle is then depressed toward the outer angle of the eye; and the blade thus brought forward, is found to have hooked up the muscle, which it subsequently divides.

DIPLOPY.

It was before remarked, that the variety of double vision which follows the operation, requires only time to disappear.

When it exists before the operation, it is generally relieved by it. A dilated state of the pupil in the affected eye, seems to contribute to it; and in rare cases it has been observed to accompany vision in a single eye.

KOPIOPY.

Is a name given by M. Petrequin,[1] to the sensation of fatigue experienced in the use of the affected organ, either before or after operation. It seems to result from the want of power in a part rarely exercised, and subsides as the eye becomes habituated to its restored functions.

[1] Annales d'Oculistique, 1841.

NYSTAGMUS.

Or convulsive trembling of the eye, is observed with or without strabismus. The ocular globe oscillates in different directions, varying with the muscles in fault. It turns in certain cases upon its antero-posterior axis, as if moved by the main-spring of a watch attached to this axis. This motion corresponds with that before referred to the oblique muscles.

When the affected muscles are divided, the convulsive action ceases, but generally returns with the reunion of the parts. If we believe M. Phillips, it is then much less marked, and diminishes until it disappears. Of four or five patients operated upon by M. Velpeau, none were radically cured.

STATISTICS.

Subjoined are the results of Velpeau and Phillips, as they have reported them.

Velpeau. — Three hundred cases. — One half completely successful. Of the other half, one-third presented a very slight deviation, exophthalmy, depression of the caruncula, fixedness of the ball, or enlargement of the lids. In the two other thirds, these accidents were very manifest, and the patients retained a deformity as striking as that which existed before the operation.

Phillips. — One hundred cases. — Seventy-five

satisfactory results; sixteen incomplete; five not improved; in five the eye directed outwards. Of divergent Strabismus, ten satisfactory, five incomplete, one not improved.

The constant success reported by Dieffenbach, induced a M. Melchior to examine a number of his patients. In a Latin essay upon the subject, published at Copenhagen, he states that of forty-four patients, but ten were found to be entirely relieved, and fifteen partially so.

The results of Bonnet, Chassaigne, and Baudens, are before me; but the bearing of their statistics is less obvious, as they interpret differently the term *success*.

STAMMERING.

The operation for strabismus suggested that for stammering. When it was ascertained that spasmodic contraction of the muscles of the eye, was relieved by their division, it was inferred that the proposition was general, and a new field was sought for its application. The characteristics of stammering were too obvious to escape notice, and hence the operations for its cure.

Dieffenbach in Germany, and soon after Velpeau and Amussat in France, announced their methods.

The results have not answered expectation, as might have been inferred from the complicated nature of the mechanism of the vocal organs. But such was not the belief of surgeons, and the tongue was carved and tied, above and below, in any way which seemed to offer a possibility of

modifying its previous physiological conditions. The different operations were indiscriminately applied. It sufficed that a man stammered, and the genio-glossi muscles, or the entire thickness of the tongue, were condemned to the knife.

As was natural, a few patients improved, after so severe a lesion of the parts more or less concerned in the affection. Phillips states the proportion at only five per cent.; an estimate which has called forth the remonstrances of more ardent advocates of the operation. Allowing for exaggeration, the method of Dieffenbach, the bisection of the root of the tongue, seems to have been followed by greater success, but is by far the severest operation.

It is evident that the machinery of articulation has not been adequately analysed, with reference to the operation, and that the indications of derangement of its various parts have been too little considered. A first step then, towards the study of this affection, is an analysis of the articulate sounds, and of the manner of their production, of which, a sketch proportioned to the limits of this paper is here offered.

The mouth, including the trachea and the lips, may be considered as divided at will by four diaphragms, necessary to articulation, and capable of intercepting, both wholly or in part, the air expelled by the lungs. The first of these is the vocal chords; the second, the root of the tongue; the third, the tip of the tongue; and the fourth, the lips. To these four, each by itself, or aided by the

nasal cavity, may be referred most, if not all, articulate sounds.

1. The vocal chords, by their vibration, produce the voice. To them is due only such articulation, if we may so call it, as is produced by their sudden relaxation, when it coincides with an expulsive effort of the lungs; an effort termed by elocutionists, exploding. They antagonize each other.

2. The root of the tongue, is opposed by the soft, and the posterior extremity of the hard palate, as in *k*.

3. The tip of the tongue is antagonized by the front upper teeth, and by the bony palate, as in *the*, *t*.

4. The lips are opposed, either one to the other, or the lower one to the upper front teeth, as in *p*, *ph*.

Sounds are modified by two conditions of each articulating isthmus. 1; when shut; 2; when partially opened. Thus with the lips, *p*, *f*; with the tip, *t*, *th*; with the root, *k* and *ch* in the German *nicht*. The same sounds are modified by the addition of the voice, thus, without the voice *p*; with the voice *b*; so *t*, *d*, *k* and *g* hard.

A third and last alteration of the same sounds, is effected by the opening of the nasal cavities, by which *b* becomes *m*, *d*, *n*, and *g* hard, *ng*.

Such are the regular principles of articulation. To these may be added three exceptional and irregular sounds, produced by the tip of the tongue against the hard palate.

1. A whistle analogous to the whistle of the lips, as in *s*, and a little farther back, *sh*.

2. The sound of *l*, produced by the lateral application of the tip and edge of the tongue to one side of the hard palate, while the air passes by the other side.

3. The vibration of the flexible extremity in the letter *r*.

This sketch may be condensed, as in the following table.

	Lips. shut	Lips. partly open	Tip of Tongue. shut	Tip of Tongue. partly open regular	Tip of Tongue. partly open irregular hissing	Root of do. shut	Root of do. partly open
with voice	b	v (1)	d	th-ough (2)	z. j (*french*) (3)	g hard	
nasal	m		n			ng	
without voice	p	f. ph.	t	th-ing	s. sh.	k. q.	ch in *nacht* (6)

	Tip of Tongue. partly open irregular	
with voice	r (4)	l (5)

(1.) The letter *v* though formed between the front upper teeth and the under lip, is identical with the sound produced by a slight separation of the lips; as in the Spanish *Habana*, pronounced like the English *Havana*, though formed by the lips. In the latter case, it is somewhat exaggerated.

(2.) Were the palate flat, it is probable the sound *th* would be produced by the position of the tongue which now forms *s;* to avoid which, its extremity is advanced to the teeth.

(3.) The concavity of the palate, with the similar opposing one of the tongue, produces the whistling *s* and *z*. A short distance farther back it is more diffused, and becomes the hissing *sh*, and French *j*, as in *jarret*.

(4.) That *r* is a vibration, is shown in its exaggeration in the Italian language; thus *giorno; avér* for *avére*.

(5.) *L* is an irregular sound, produced by a partial but firm interception of the current of sound, by the tip and edge of the tongue applied to the palate.

(6.) *Ch* in the German *nacht*, is perfectly analogous to *ph* and *th* in English.

It will be seen that this table refers only to the enunciation of the consonants, which may be considered as the interruptions and interceptions of the vowels, and therefore more immediately concerned in the defect of stammering. The original sound produced by the vocal chords, is modified, but not intercepted, during the production of a vowel. A

complete interruption occurring after the sound has left the larynx, forms a consonant.

If stammering, in its common forms, be a spasmodic contraction of the muscles concerned in the mechanism of articulation, it is probable, although direct proof is wanting, that it may exist at either of these four points, and that each may be the seat of a variety of the affection, which it becomes important to distinguish from the rest. Some indication of the character of the affection, may be drawn from that of the sounds emitted. But this is an uncertain test. An anterior portion of the mechanism, if deranged, will be liable to interfere with that behind, and vice versâ. Thus *p* masks *t*, and *t* interferes with the articulation of *p*. When in confirmation of these views, we consider the different degrees of this affection, from the simple lisp, to the confirmed stammer accompanied with distressing convulsions of the whole countenance, it is evident that the lesion is a complicated one, and that in its different forms, it demands a different treatment. We cannot but wonder at the temerity of surgeons, who when the patient stammered, at once condemned him to the knife, and indifferently divided the genio-glossi muscles, or subjected the entire tongue to a bloody bisection, with a vague intention of modifying its nervous condition.

An adjustment of the machinery of articulation, can be based only upon a thorough analysis of its complicated action. An outline of this analysis may be found in the foregoing table, and such must be the

groundwork of any future efforts to identify the different forms of this affection.

The remainder of this article, will be devoted to an account of the different operations, which have been of late years practised in this affection.

HISTORY.

The French *Journal des Debats* of January 2d, 1841, contained the following original announcement at Paris, of the operation of Dieffenbach.

"We read in a German paper, that a discovery of Professor Dieffenbach, excites at Berlin, general attention. This surgeon has found the means of curing stammering by an incision of the tongue. The operation he has performed, has completely succeeded. According to Dieffenbach, stammering arises from an impossibility of applying the tongue to the palate. His method consists in putting an end to this inconvenience."

These indications were not lost upon the French surgeons. Some of them laid claim to previous verbal suggestions of an operation. Others, adopting the principles hinted at by Dieffenbach, sought to discover his method; and hence resulted what is known as the French operation. It was announced nearly simultaneously by Amussat, Phillips, Baudens and Velpeau. It subsequently appeared, however, that the surgeon of Berlin employed a different method. With the intention at once, of enabling the patient to antagonize the tongue with the roof of the

mouth, and of "changing the innervation," he practised a deep transverse section, sometimes with loss of substance, at the root of this organ.

The French method had reference only to the liberty of the tip of the tongue, and consisted in the division of the genio-glossal muscles and other parts beneath.

The different French operations are essentially the same, and the literature upon this subject relates chiefly to the operation, and is, for the most part, polemic in its character.

METHODS OF DIEFFENBACH.

The theories upon which Dieffenbach founded his operation, are explained in the following quotations.

1. "*Shortening of the muscular substance.*" [1] It is especially upon this last method, (excision of a piece of the tongue,) "that I have founded the greatest hope; because it had for its result, the shortening of the tongue, and enabled it to touch the superior wall of the buccal cavity; a movement, the developement of which is especially sought." * * * (P. 436) "The patient, after operation, has a sensation of a shortening of the tongue, and of an elevation of the point against the palate."

2. *Change of Innervation.* "As I thought that the derangement in the mechanism of language

[1] Dieff. in the Annales de la Chirurgie Française et Etrangere. Paris, 1841. t. i. p. 422.

which produces stammering, had a dynamic cause, which I regarded as a spasmodic state of the air tubes, which resided especially in the glottis, and which was communicated to the tongue, to the muscles of the face, and even to the neck, I ought to conclude that, by interrupting the innervation in the muscular organs, which participate in this anormal state, I should succeed in modifying it, or in causing its complete cessation.

"It is for this reason that the transverse section of the muscular substance of the tongue, seemed to be an enterprise worthy of being attempted, and of which the success seemed to be infallible; like the efficacy of the transverse section of muscles, in a great number of spasmodic affections."

To accomplish these ends, Dieffenbach employed successively, three different methods.

1. A horizontal transverse section of the root of the tongue.

2. A subcutaneous transverse section of the root of the tongue, preserving the mucous coat.

[1]3. A horizontal section of the root of the tongue, with excision of a triangular piece, in its entire breadth and thickness.

A. *Method of Excision.* The patient is seated, his head supported against the chest of an assistant. The tongue is protruded and seized upon its edge, by the teeth of a "pince de Museux." Thus laterally compressed, it gains in thickness, a con-

[1] Lettre a l'Acad. Roy. des Sciences; printed at Berlin.

dition favorable to the operation. Being then carried forward and a little to the right, by one aid, while another draws apart the angles of the mouth with blunt hooks, the root is seized by the thumb and fore-finger of the operator's left hand, laterally compressed, and raised. The blade of a bistoury, edge upward, is entered at the left side of the root, penetrates to the opposite surface, and cuts its way out from below upwards. The posterior edge of the wound being fixed by a strong suture, the anterior border is seized with toothed forceps, laterally compressed, and cut off with a narrow bistoury. The piece thus removed is wedge shaped, the base about three-fourths of an inch in breadth, corresponding to the mucous surface, and has been compared to a slice of melon. The posterior edge is then brought forward by means of the suture and a small hook, and united to the anterior edge by six strong points of suture, which, traversing the bottom of the wound, impede hemorrhage.

In subsequently removing the first ligature, if it be followed by an oozing of blood, it is an announcement that the cicatrization is not yet solid, and the surgeon should desist. This fact, and the manner of arresting the hemorrhage by deep sutures embracing the mass of the tongue, may serve as hints for other operations upon these parts.

B. *The Simple Section of the root of the Tongue* resembles the preceding method, without the removal of the wedge shaped mass.

C. *Subcutaneous Section of the root of the*

Tongue. In this operation, the upward section terminates, before dividing the mucous coat upon the superior surface of the tongue.

Dieffenbach thus speaks of the dangers of the operation:

"The loss of the tongue by gangrene or by extensive suppuration, or even by the want of dexterity of the assistant who may easily tear it, are considerations which require to be maturely weighed, and which, joined to the difficulties which it presents, will hinder operators of little experience from wishing to attempt it."

FRENCH OPERATION.

The propositions of the French surgeons embraced the principal points presented by Dieffenbach. The conditions supposed to accompany stammering, indiscriminately in all its varieties, are thus enumerated.

1. Slight deviation of the tongue to the right or left.

2. Impossibility of pressing the tip of the tongue against the upper lip, without the aid of the lower jaw, which advances to support it.

3. Spasmodic agitation of the tongue during the act of phonation.

To these Velpeau, Amussat, and others, added a fourth proposition.

4. A remarkable developement of the genio-glossal muscles, the frenum being strong and hard.

The division of these muscles is the aim of the French operation. The different methods are subjoined.

Method of Phillips. The patient is seated, as in the operation of Dieffenbach. The surgeon seizes the frenum at its angle of reflection upon the tongue, with a hook, bent at right angles, that it may not impede his subsequent manipulations, and confides it to an aid. He then implants a second small hook in the frenum, at a half line distance from the ducts of Wharton, and between the two hooks, divides largely the mucous coat, with scissors. Laying aside the scissors, he introduces by the wound, a blunt hook edged upon its concavity, and collecting upon it "all the muscular mass of the tongue," divides it with a sweep of the instrument.

Phillips, it is seen, severs the muscle near its fanlike expansion in the tongue. The other methods deal with a point nearer the jaw, where the muscle is less voluminous and less vascular.

Methods of Velpeau. 1. The tongue is held by the left hand, armed with a linen, and drawn aside. A puncture is made with a lancet, at the right of the frenum near the under jaw. A tenotome is plunged in the aperture, to the depth of three-fourths of an inch, and the genio-glossal muscles are divided, without enlarging the incision of the mucous membrane.

2. In another case the section was made with scissors.

3. In a third patient, M. Velpeau removed a triangular mass from the point of the tongue, and the wound was brought together by sutures.

4. In a fourth, the anterior pillar of the velum palati, which contains the palato-glossus muscle, was divided, but without success.

5. At a subsequent operation, this surgeon strangulated by ligature a mass, resembling in size and position, the wedge removed in the operation of Dieffenbach. The tongue being drawn forward, was traversed at its root by a needle, armed for strength with four threads. Two were tied over the back of the tongue. The two others were tied in the same way, a little in advance of the first, thus insulating a portion of the tissues, which subsequently sloughed away.

Method of Amussat. The surgeon first divides the frenum, with the mucous membrane on each side, and the salivary glands, avoiding the ducts of Wharton. If no advantage is gained, the genio-glossal muscles are divided near the apophyses. If, during this process, the tongue be thrust forward and upward, the muscles spontaneously offer themselves for section, and are easily divided with knife or scissors.

Of Baudens. This surgeon employs pointed scissors bent at an elbow near the pivot, like Roux's scissors for the operation of staphyloraphy. Slightly opened, they are thrust to some depth astride the genio-glossal muscles, which are then divided at a

single stroke. The genio-hyoid muscles are sometimes included in the section.

Of Lucas of London. The mucous membrane and cellular tissue, are dissected to the extent of an inch, in the method of this surgeon, for the purpose of exposing and avoiding the ranine arteries, the large veins, and a branch of the lingual nerve, which borders the outside of each muscle. The muscles are divided, and a triangular fragment whose base corresponds to the surface, is detached.

Subcutaneous Operation. M. Bonnet has proposed a puncture beneath the chin, at the distance of an inch behind it. A tenotome is introduced, and thrust upward, its edge toward the bone. When it is perceived beneath the mucous membrane, the surgeon feels for the insertion of the genio-glossal muscles, and cuts to the right and left. By keeping the edge of the tenotome against the jaw, and acting only upon the superior part of the convexity of the bone, upon a median line, the insertions of the genio-hyoid muscles are avoided.

ACCIDENTS AFTER THE OPERATION.

Hemorrhage. The vascularity of the parts, the size of the incision, and the difficulty of commanding the bleeding vessels, are conditions which give rise to formidable hemorrhage, with difficulty arrested by means more painful than those employed to remedy the stammering. It is obviously difficult to amass evidence upon this point. At a time when

surgeons emulated each other in reporting successful results from the operation, various motives induced misrepresentation. But the danger of hemorrhage is not altogether concealed. Dieffenbach says of his own subcutaneous method, "The blood gushed with abundance from the two lateral wounds, as if it escaped from a large arterial trunk; and the tongue soon became tumefied, by the mass of blood which accumulated in the interval of the subcutaneous section." The books allude to a student at Berlin operated upon by this surgeon, who died from the profuse bleeding attendant upon the operation.

Phillips says of this method, "It is surrounded with too many dangers to be retained in practice. The hemorrhage is always very abundant, and we possess no means to arrest it, unless by a second operation, more painful and more cruel than the first." And in another place, "The hemorrhage which follows this operation is of long duration; and I felt the greatest anxiety, after having operated upon a young man of Liége. The section of the muscles was made at eleven o'clock in the morning. At eight o'clock in the evening, the blood still gushed, as from the mouth of an open artery." Again, "I have seen patients, in my practice, lose blood seven or eight hours after the operation, without the possibility of arresting it."

M. Guersent, surgeon of the Hôpital des Enfants, has published a remarkable case of this kind, in which the patient, a child of twelve years, was pre-

disposed to hemorrhage. After the operation, by Amussat's method, the hemorrhage commenced, and was renewed at intervals for ten days. During this time every means were employed to arrest the bleeding; styptics, balls of charpie, cold lotions, and finally the actual cautery, which was renewed seven times. At the end of ten days the patient presented a state of almost complete anemia, from which it slowly recovered. At the end of three weeks, *the child stammered as before*, the tongue being much shorter after the operation.

The bleeding is promoted by the inclination which patients have, to suck blood from the wound.

The hemorrhage should, in common cases, be treated by the injection of iced water; *tamponnement*; plugging with balls of lint, wet with alum or some other styptic solution. In the operation of Dieffenbach, the bleeding is impeded by deep sutures, which are drawn tight, thus compressing the mass of the tongue. The hemorrhage is usually arrested, by the formation of a more or less voluminous clot, which should not be disturbed. Phillips alludes to two cases of obstinate hemorrhage, following the removal of the coagulum.

Tumefaction of the Tongue. The enlargement of the tissues, often considerable during the inflammatory action, is sometimes such as to hazard the life of the patient.

[1] "Everybody knows the deplorable story of

[1] Phillips, Tenot. sonscut, p. 392.

a young man operated upon, whose tongue acquired a considerable volume. It formed upon the lower wall of the mouth a vast *valve*. During the night, the symptoms became more and more alarming, and the result was finally enveloped in a profound mystery. How many other examples have had the same fate!"

In the Gazette des Hopitaux, (*Juin* 1, 1841,) M. Amussat has avowed one case of death. The subject had been operated upon, in presence of a commission named by the Academy. The same journal contains also the history of a man who came near dying of asphyxia, by the enlargement of the tongue.

The tongue, left to itself after the section of the genio-glossal muscles, exercises a great force of retraction, and has a tendency to turn back upon the glottis, an accident which it has been shown may be fatal. A similar accident is to be apprehended from the posterior portion of the tongue, in the transverse dorsal incision of Dieffenbach, and hence the care requisite to secure it during the operation, by means of a suture or a hook passed through its substance.

APPRECIATION OF THE DIFFERENT METHODS.

In estimating the comparative value of the different methods, a first ground of comparison, unquestionably the most important, is their efficiency in relieving the imperfection of articulation. The

inadequacy of the operation in a majority of cases seems generally to be conceded. It has been shown theoretically, that in its application to a part only of the articulating machinery, it is incomplete. But such an avowal is not to be looked for in papers upon this subject; the aim of most of which is to herald the success of a new operation, and to give notoriety to its advocates.

To this remark there are exceptions. Dieffenbach considers the operation inapplicable in certain cases, and allows that in what concerns *the indications* of the operation, they are much more difficult to determine than in the operation for strabismus.

Of the French operation, Phillips thus speaks. "Among true stammerers, there are some who redouble the *b*, *p*, *d*, *t*, and who pronounce for example *b*, *b*, *b*, *b*, *a*, &c. These may be improved by the section of the genio-glossi, but not radically cured; the lips play a too considerable rôle in the articulation of this letter. Those who redouble the *t*, and the *a*, may be radically cured by the section of the genio-glossi, if there is not at the same time some defect in the respiration. Stammering upon *s* and *z* may be also diminished by the operation; but if it bears upon the *h*, *k*, and *m*, the operation is without effect. I have never, up to the present day, been able to appreciate the least change upon these letters after the operation."

These observations are cited, as confirming the analysis of sounds laid down by the writer in the beginning of this article.

The articulation of the consonants mentioned by Phillips, as affected by the section of the genio-glossi, will be found referred in that table to the tip of the tongue, and consequently directly influenced by the liberty of that part of the organ.

M. Chassaigne,[1] another writer upon this subject, in opposing this theory of Phillips, cites a case in which the pronunciation of the sentence "*Maman m'a mandé*," was facilitated by the section of the genio-glossi. It is probable that in this case the affection existed, not in the labial muscles, but in those of the tip of the tongue, the spasmodic action of which, masked or impeded the labial articulation. Such mistakes have arisen from an insufficient study of the varieties of the affection. In most reported cases, it sufficed that the patient was unable to articulate certain test words, like those alluded to, or "*Kakoski, Colonel des Cossaques*," "*hippopotamus*," "*concupiscence*," and he became a subject for the operation, according to the method then in vogue. If after this lesion of the buccal cavity, the spasmodic action of the muscles ceased for a time, the operation was proclaimed satisfactory in its result. Such has been the operation I have often witnessed in the Paris hospitals, and such are the majority of printed observations.

Authors seem to allow to Dieffenbach, a greater share of success than to other surgeons. No means of estimating the value of his assertions upon this

[1] Traité du Strabisme et du Begaiement. Paris, 1841, p. 140.

point are at hand. It is however difficult to give full credit to statements like the following. [1] "I have within a short time operated upon fourteen stammerers, in removing a triangular piece of the tongue, and in all, the stammering has entirely ceased." It may be suspected that at the end of a longer period it returned, at least in some of the cases.

It is easy to imagine that in promiscuous operations upon the different varieties of the affection, the section of Dieffenbach, which involves all the lingual muscles, should more readily alter the functional conditions of the tongue, than the division of the genio-glossi alone. But if the division of muscles be its object, this method attacks indiscriminately the interweaving fibres of all the fasciculi, without bearing directly upon the body of either of them. On the other hand it is difficult to establish how far it may alter the innervation of the part; neither is this proved to be the essential end of the operation. If the previous length of the lingual surface interfered with the power of opposing the tip to the palate, the removal of a portion of the dorsum might tend to obviate this difficulty; but much less directly than the division of the genio-glossal muscles.

Until the applicability of the German operation be clearly indicated, and its efficacy shown, the profuse and dangerous hemorrhage, the tumefaction, and other inflammatory accidents to which it is liable, are insurmountable objections to it.

[1] Dieff. Gazette des Hopitaux. Mars. 18, 1841.

The same is true in a less degree of the French method, which however probably applies to a greater number of cases, and is less objectionable when the point of section approaches the jaw-bone, as in the subcutaneous section of Bonnet, which is confined to the tendinous insertions of the muscles. The analogy of this method to the simple section of the frenum in tongue-tied children is obvious. It is sometimes employed with advantage where the tongue is not confined, where the spasmodic condition of the genio-glossi muscles can be clearly demonstrated.

The method of Velpeau, by ligature, offers a smaller chance of hemorrhage, but is even more subject to violent inflammatory accidents. The removal of a triangular mass from the anterior part of the tongue and from the genio-glossal muscle, the division of the genio-hyoid and other equally fanciful sections, are evidently experimental.

Authentic statistics of the results of these different operations will not be expected, when the unscientific character of most of the papers upon this subject is considered.

The following results, those of Dieffenbach excepted, refer to the French method. *M. Baudens* says, "we count at this time twenty-one persons operated upon by our method. All have obtained, if not an absolute cure, a notable amelioration." It is sufficient to add, that of strabismus, the same author remarks, "of eight hundred squints that we have operated upon, * * * *in every* case we have

succeeded ; let skeptics put us to the test ; let them give us the most desperate cases, and when we have failed once, we will yield to the evidence." Such assertions need no comment.

Dieffenbach has been elsewhere quoted, " fourteen cases operated upon, among all of whom the stammering has entirely ceased."

Chassaigne, among seventeen cases, gives seven cured, five ameliorated, and five without beneficial result.

Finally, *Phillips* concludes his essay as follows: " of one hundred individuals speaking badly, called improperly stammerers, we find only five subjects really stammering ; and these alone are fit to be operated upon with success. Of these five individuals, we count two or three who stammer only upon the lingual letters. In these cases the operation is brilliant in its results ; the stammering ceases entirely. The two others stammer upon linguals and labials, and then the operation affects the stammering of the linguals alone, and hardly modifies the stammering of the labials.

" I have seen in the service of M. Velpeau a case of brilliant success, after an operation upon a subject who stammered, *i. e.* redoubled the linguals.

" The ninety-five other individuals do not stammer, but speak badly ; either because they shut the mouth in trying to talk, or because they do not breathe, or because they cannot or do not know how to make use of the tongue to aid articulation, or finally because they have nothing to say."

TENOTOMY.

The division of tendons is an operation of ancient date. *Tulpius*, in 1685, refers to *Isacius Minius*, as having practised it. It was at that time considered a grave and dangerous operation, and *de la Sourdiere* in 1742, terminates a memoir in the following words. "The section of tendons ought then to be avoided." In 1782 or 1784 *Lorenz* divided the tendo-Achillis at the request of *Thilenius*, a physician of Frankfort; and *Michaelis* soon after effected, though incompletely, the same section.

Until recently, it was the custom of surgeons to incise the integuments with the tendon, the severed extremities of which were freely exposed to the air. In these conditions, the divided tendinous surfaces remain for a length of time pale. Slowly they become vascular, granulate, until the vegetations fill the surrounding void, and finally heal, with a dense

firm cicatrix, which involves cellular tissue, aponeuroses and integuments. The sliding of the tendon is thus impeded, and in its restricted movements, it bears with it the surrounding and adhering tissues. The restorative process is in such circumstances tedious; and the constitutional reaction, and consequent hazard to the patient considerable.

At the present day, the division of tendons is a trifling operation, and almost divested of danger.

Delpech first proposed a section which should not denude the tendon. A bistoury was passed beneath the skin, which it traversed at two points, as if for the passage of a seton. The incision was extended to the length of about an inch, and the tendon was divided.

Stromeyer and before him *Dupuytren*, according to Velpeau, indicated the method by simple punctures. The latter surgeon confined himself to a single orifice, which gave admission to the instrument, taking care not to wound the integuments of the opposite surface. This is essentially the method of the present time, and the most simple which science now possesses. It has undergone two modifications, referred respectively to *Stoess* and *Bouvier*.

In the method of *Stoess*, the knife is introduced beneath the tendon, which is divided from within outwards. *Bouvier* enters the instrument beneath the skin, and divides the tendon from the surface towards the deep seated parts.

The field of *subcutaneous operations*, effected by a simple puncture of the integuments, and applied

to muscles and aponeuroses as well as tendons, has been widely extended by various surgeons; among whom *Dieffenbach* and *Guerin* are conspicuous. The exclusion of air, is the aim and characteristic of this method. A degree of vitality is thus retained in the injured parts, and even in the effused blood, which favors in a remarkable manner their restorative action. The functions of absorption and secretion are carried on with a rapidity, to which the presence of the atmospheric fluid seems fatal.

An entirely new class of operations by this method, has sprung into existence, to which the remainder of this paper will be devoted.

SUBCUTANEOUS CICATRIZATION OF DIVIDED TENDONS.

It is well known that a tendon, when divided beneath the skin, is disposed to retract, leaving an interval between its extremities, at the point of section. In most cases the interval is obliterated, and the continuity of the tendon reëstablished, by the gradual deposition of an intermediate fibrous tissue. Observers differ with regard to the manner in which this tissue is formed; and experiments have led to apparently opposite results.

Stromeyer, in attributing the deformity of certain club-feet to muscular contraction, asserts that the length of the newly formed tendon, which he compares to a thick ring, is alone insufficient to account for the redressment of the deformity; and supposes

that the muscle, once relieved from the stimulus of tension, elongates itself, until the divided tendinous surfaces are brought into contact. On the other hand it may be urged, that the interposed mass is often considerable. In one experiment of Bouvier, its length was nearly two inches at the end of twenty-four days. It is possible that the tendinous end, enlarged at its point of union with the newly deposited matter, may have been mistaken by this surgeon, for the entire substance of the cicatrix.

One class of observers, among whom are *Held* and *Bouvier*, suppose that the tendinous sheath, with its surrounding cellular tissue, undergoes a gradual transformation into fibrous matter, with agglutination of its walls, and obliteration of its cavity. Others, leaning to the theory of *Hunter*, assert that the cavity of the sheath is a receptacle of blood and of lymph, which is afterwards organized and converted into tendinous fibre. Such, are *Ammon*, *Guerin*, *Phillips*, *Duval*.

The result of the detailed experiments of *Bouvier*[1] on one side, and *Ammon*[2] on the other, render it probable that the restorative action varies in different circumstances, and accommodates itself to the pathological conditions of the parts. In the experiments of *Ammon*, the effusion of blood was constant; and was probably due to a laceration more

[1] Mem. de l'Acad. Roy. de Med. t. vii.

[2] Exper., t. I., p. 155.

or less extended, of the fibrous envelope and surrounding cellular tissue. This hemorrhage was of rare occurrence in the cases of *Bouvier;* and we infer that care was taken to divide the tendon, without injury of the neighboring parts. Whether with *Guerin* we consider the effused coagulum to be a condition essential to the process of restoration, or with Velpeau view it as an accidental complication, it is evident that such a body of fibrin, interposed between the divided tissues, must modify the process which nature sets up where no such foreign body exists.

The experiments alluded to, seem to establish the following propositions.

When the fibrous sheath is little injured, and when there is a free communication between the divided ends of the tendon, the tissue of the sheath becomes dense and indurated by the deposition of fibrous matter, and layers of cellular tissue are successively impacted upon its exterior. In the mean time, its cylindrical cavity, strangulated at the centre, gradually contracts; lymph is exuded in its interior; the extremities of the tendon assume a conical form, and uniting with the sheath, the whole mass finally acquires the character of a dense fibrous cord.

But when the surrounding tissues are divided, and a coagulum is deposited in the wound; when, instead of the fibrous sheath ready at hand, to be converted into tendon, a foreign body, as it were, is interposed between the divided surfaces, the

process of restoration is different. While the wounded surfaces exude lymph, the coagulum plays the chief part in the formation of the new tendon. It becomes gradually organized. Its substance is penetrated with vessels, which, in their turn deposite plastic matter, until the severed extremities are at length united by a few filaments. These increase in size, acquire a compact texture, and are fused in time into a fibrous resisting mass.

GENERAL CHARACTERS OF DEFORMITY.

It is probable that all congenital distortions of the trunk and limbs, are the result of muscular contraction, originally induced by an affection of the nervous centre or its branches.

At the period when the surgeon is called to operate, it is no longer active, and he deals only with its results, as presented by certain modifications of the muscles, fibrous tissues and vessels.

The original affection, being a spasmodic action of the muscular fibre, has received from Guerin the name of *contraction;* while the consequent and permanent lesion, as exhibited in the partial or entire change of the muscular into a fibrous tissue, has been called by the same writer, *retraction.*[1] The duration of the state of simple contraction is indefinite ; and during this period, the soft parts may

[1] To this condition, Little has applied the term, "*structural shortening.*' Lancet, Dec. 9, 1843. p. 39.

be elongated by proper means. But the fibrous change is attended with rigidity, unyielding in proportion to the extent of the transformation.

Most cases of club-foot present these characters, and date either from fœtal existence, or from some convulsive affection of early life. Their leading and distinctive feature, is a tenseness of certain tendons, which become especially evident beneath the integuments, when an attempt is made to correct the deviation. They are then rigid and salient, and manifestly interfere with the normal position of the limb.

Retracted muscles are generally found upon dissection, to be pale, atrophied, and partially converted into fibrous tissue. They are more or less completely paralyzed, and their developement has been arrested. The *fatty transformation* is more rare, and of less importance to the surgeon. It has been doubted whether it be possible to detect this lesion through the integuments. When it interferes with the restoration of the limb to a normal position, it is generally more or less combined with the fibrous change.

Guerin has laid down two rules, with regard to the change which the muscles undergo, when thus permanently contracted.

1. In all chronic deformities, the muscles, instead of continuing their primitive relations with the distorted portion of the skeleton, tend to become shorter, and to direct themselves in a straight line, between their two points of insertion.

2. The transformation of muscles is fatty or fibrous; fatty, when the muscles are compressed, and left to themselves; fibrous, when they are submitted to exaggerated traction.[1]

The tendons and ligaments seem rather arrested in their developement, than changed in form. In a state of repose, the fibrous cords become more compact, and are not unfrequently changed into bony matter. Guerin supposes that this osseous deposition only occurs, when the muscles become fatty; but the position has been disputed by other surgeons.

The arteries do not follow the muscles in their deviation. They are neither shortened nor tense and straight. "They accompany the muscular curves when they are attached to these muscles, and become tortuous when free; the more so as the distance they traverse is more limited."[2]

The nerves tend to diminish in length, and to adapt themselves like the muscles, to the cord of the curve produced by the deformity. This disposition to retract, is attributed by Guerin to the fibrous tissue of the neurilemma.

The veins dilate and increase in number; modifications, supposed by Guerin to explain the fatty transformations of the tissues in general. The tendency of the skeletons of deformed limbs to exude a greasy matter is well known.

[1] Vues. Gen., etc. p. 23. Paris, 1840.

[2] Op. cit. p. 25.

INSTRUMENTS AND MANUAL OF THE OPERATION.

The *instruments* contrived for subcutaneous operations are exceedingly numerous, and the more important ones will be alluded to in another place. Many of them offer useless complications and refinements. The sections may all be effected with one or two *tenotomes*. The most useful consists of a blade, about an inch in length by one eighth of an inch wide, pointed, and slightly convex. Attached to a short cylindrical shank, it serves to divide the larger tendons. Probe pointed, straight on its edge, and with a longer shank, it may be used for the broad or deeper-seated fibrous tissues. (Figs. 8, 9.)

The tension of the tendons, is by far the most important of the indications for their division. When it is ascertained that their retraction interferes with the normal position of the part, it is expedient, as a general rule, to divide them; beginning with the most rigid and salient.

The manual of the operation is briefly as follows. The region being placed in a convenient position, the tendon to be divided is made tense, and if possible evident, beneath the integuments. This is effected either by the position of the patient, by voluntary contraction of the muscle, or by external force properly directed.

Guerin pinches up, immediately over the tendon, a fold of skin, one end of which is confided to an

aid, and introduces the tenotome flatwise at its base. He then releases the integuments, and the puncture recedes to a distance from the point of section, while the blade retains its position near the tendon. The tendon is now made tense by active or passive flexion or extension, and divided by a slight sawing movement of the knife.

It is unimportant whether the section be made from without, or within the tendon, if there be no especial indication, such as the neighborhood of large vessels, to guide the operation. A place of section should be chosen, where the tendon is surrounded by cellular membrane. It is rarely possible to obtain union, in the cavity of a synovial sheath; and permanent deformity has resulted from division of the tendon in this position.

At the moment the section is completed, a noise is heard as the two ends suddenly recede from each other; modified and exaggerated, if it be near the region of the thorax. The instrument is withdrawn as it was entered, the integuments being compressed as the knife recedes, to hinder the admission of air. As the blade leaves the puncture, the finger arrives at and covers it, until it is effectually sealed by a bit of adhesive plaster.

HEMORRHAGE.

If the hemorrhage be considerable, a tumor occupies the seat of the effusion, and the blood is to be expelled by the puncture as far as practicable.

It is more frequently distributed in the cellular membrane, and left for subsequent absorption. Alarming hemorrhage is rare, as the larger vessels are not involved in the operation.

In some experiments of M. Amussat, which I saw at the Abattoir Montmartre, the open vessel, even when of considerable size, if completely divided, occupied the centre of a coagulum, the walls of which acquired such tenacity, as to confine the fluid nucleus, and arrest the effusion.[1] In deep sections additional security is offered, by the flexibility of the vessels, which yield to the edge, while the resisting tendon is divided. Hence it is better in such positions, to avoid as far as possible the sawing movement of the instrument, and to divide the tendon by force perpendicularly applied to it.

MECHANICAL TREATMENT.

It is now generally allowed, that an immediate application of mechanical force is not indicated. Inflammation, re-opening of the puncture, admission of air and suppuration, were not unfrequently the sequence of the operation in past years. These accidents have become less common, since attention has been directed to the cicatrization of the integuments, before beginning the mechanical treatment.

1 These results have been since generalized, by farther observations upon hemorrhage in the human subject. *Amussat. Commun. a l'Acad. des Sciences. Oct.* 28, 1844.

The principle of the various machines contrived for this purpose, is simple. Their object is to direct and maintain a permanent effort, against the curve of the deformity. A separate part of the apparatus is adjusted to each detached portion of the skeleton, while the centres of movement of the machine, correspond to the articulations, and are fixed by ordinary mechanical expedients, such as a ratchet-wheel, rack and pinion, or best by a perpetual screw. (Figs. 16, 17, 18.)

Of mechanical treatment without division of the tendon, little need be said. It is often efficient in infancy, and in certain cases of spasmodic and of slight deviation. But in a common case of chronic deformity, two elements oppose the return of the parts to a normal condition; the distortion of the bone, and the tension of the unyielding fibrous tissue, which approximates its extremities. In severing these fibres, we remove one of the chief impediments to the restoration of the part; as is evident from the sudden separation of the divided extremities. It has been abundantly proved that, under proper restrictions, the operation is safe, and that while the duration of the treatment is abridged, there is less chance of a return of the deformity, than when unaided mechanical treatment is adopted.

CLUB-FOOT.

CERTAIN rare cases of this distortion result from idiopathic malformation, or other lesion of the bony tissues; but by far the most numerous class is due to muscular agency.

Club-foot has been defined to be the result, "of[1] inequality in the antagonizing muscular forces, and of the permanent retraction of certain muscles."

CAUSES.

Its causes may be considered in two classes, with reference to the period of their influence. 1; Congenital. 2; Consecutive.

1. *Congenital.* Among the probable influences supposed to act during the fœtal state, are the following.

[1] Traité pratique du Pied. Bot. par Vincent Duval. Paris, 1843.

A. An intrinsic muscular contraction, due to the agency of the cerebro-spinal system. As the most frequent cause of club-foot, it is by far the most important to the surgeon. It produces a large majority of the cases with which he is called upon to deal.

B. The mechanical pressure of the uterine fibres, or the bad position of the child.

The first of these causes has been investigated by Guerin, who considers convulsive muscular contraction as the essential cause of the congenital form of the distortion. His theory is founded, 1. Upon dissections of fœtal monstrosities and deformities, where lesion of the nervous centre or its ramifications was evident. 2. Upon the fact that it often accompanies strabismus and other deformity, manfestly due to convulsive action, in different parts of the system.

In confirmation of this position he offers, with other evidence, the following remarkable observation. Twin infants were affected with double congenital club-feet, which at the end of six months had assumed a natural position, under treatment. At this time, one of the infants was seized with convulsions, accompanied with a return of the club-feet, which were treated anew with success. At the end of a year, fresh convulsions occurred, and the distortion was again reproduced in one of the feet, though in a less degree.[1]

An unequal pressure of the uterus has been as-

[1] Etiologie Generale des Pieds bots congenitaux. 1843.

signed as a cause of fœtal distortion; but this explanation admits of doubt. The presence of the water of the amnios would tend to counteract such pressure; upon which ground Breschet rejects the theory, while Guerin, on the other hand, maintains that a certain lateral, but uniform flattening of the foot, may result from this force. Duval offers a number of observations, tending to show that certain positions of the child during uterine life, may induce deformity. In these observations, the club-foot was accompanied by distortions, which were evidently exaggerations of the natural position; such as a permanent folding of the arms, the thighs being flexed upon the pelvis. They seem rather to indicate a general tendency to muscular contraction, than a distinct cause of the development of club-foot.

c. Guerin discards the doctrine of an *arrest of developement*, advanced by Breschet, as an original cause of distortion, but admits the influence of this principle as a consequence and aid of muscular retraction.

2. *Consecutive.* These sources of distortion are more readily appreciated. Among them are, *wounds* of the leg or plantar surface, *blows* and *sprains.* That variety which results from wounds, or from disease of the bones, generally bears marks of the lesion which has provoked the deformity; and cicatrices and contractions of the integuments, supply the place of the distinctive marks of *retraction.*

It is generally allowed that the *paralysis* of certain muscles may produce distortion, by permitting the unopposed contraction of the antagonizing muscular forces. The subsequent transformation of these muscles, then permanently confines the limb in its new position. The majority of operators advocate tenotomy in such cases, when the distortion materially interferes with the convenience or comfort of the patient. The deviation once corrected, the traction of the healthy muscles may be counteracted, and the normal position maintained, by springs, or other mechanical contrivances. In this way the condition of the patient is often very considerably improved.

Both in the congenital form, and in chronic cases which result from spasmodic action, occurring at a period subsequent to birth, we meet with the conditions of *retraction* before described. The muscular fibre has given place to a more or less fibrous tissue. It has become pale and atrophied; its developement has been arrested, and the points of its insertion are approximated. Beneath the integuments, are found a series of tense, salient cords corresponding in position to the tendons, and especially evident, when an effort is made, to restore the foot to a normal position.

VARIETIES.

Most authors recognise three varieties of club-foot; viz: *Equinus*, *Varus*, and *Valgus*.

1. *Equinus.* When the heel is drawn towards the calf, and the patient walks upon the toes or metatarsal extremities, like the horse, which gives the name to the distortion.

2. *Varus.* When the plantar surface is turned inward, and the limb rests upon the outer edge of the foot.

3. *Valgus.* When the sole is directed outward.

To these are added a rare variety called *Talus.* Here the toes are drawn upward, upon the front of the leg, while the heel alone remains upon the floor. It is directly opposed to *Equinus.*

Modern writers have proposed other divisions.

Duval proposes the general term *strephopodie* (στρέφω-ποῦς) for deviation of the foot, and varies its application by the insertion of the prepositions, ἔνδον, ἔξω, ὑπο, ἄνω, κάτω;—thus streph-endopodie,—exopodie, — ypopodie, — anopodie, — ocatopodie, for deviation inward, outward, under, upward and downward.

The division of *Bonnet* is more worthy of attention. He divides [1] club-feet into two classes.

1. Those forms produced by the retraction of muscles supplied by the external popliteal nerve.

2. Those produced by the retraction of muscles, to which the internal popliteal nerve is distributed. Thus the internal popliteal club-foot includes the varieties Equinus and Varus; while the external, much less frequent, consists of the different degrees of Valgus and Talus.

[1] Sect. tend. 1841, p. 432.

The amount of distortion is marked by degrees. Thus Dieffenbach divides each of the three ordinary varieties into five degrees. Phillips and Guerin into three. Bonnet subdivides his two varieties, each into five degrees.

I adopt the most familiar classification, and shall describe three degrees of each form of the affection.

EQUINUS.

The *first* degree of equinus, consists of a direct elevation of the heel from the floor, due to the gastrocnemii. In the *second*, this action is exaggerated, and often complicated by the action of other muscles. In the *third*, the toes are bent backwards under the foot, and the bony frame-work is more or less distorted.

First Degree. The subject walks upon the extremity of the affected foot, of which the toes are more or less extended towards a right angle. The calcaneum is carried upward, and the astragalus slightly dislocated forward. The retracted muscles are those attached to the tendo-Achillis, and occasionally the extensor of the great toe. The foot is slightly arched, and shorter than its fellow. It presents upon its plantar surface two callosities, corresponding respectively to the heel and ball of the foot, the latter being well developed. The toes are elevated, partly by the weight of the body, and partly by the contraction of their tendons.

Second Degree. The mode of walking is an exaggeration of the last; the foot often inclining to one or the other side, when the muscular tension is unequal. The skeleton presents a similar position of the calcaneum and astragalus, the former of which sometimes touches the tibia, while the extension of the toes, throws the weight of the body upon the articulating extremities of the metatarsals.

Besides the retracted muscles of the calf, the extensors, and in some cases the flexors of the toes, begin to appear beneath the integuments. The foot is shorter and broader, the heel and toe being drawn together, as Guerin supposes, by the retracted fibres of both surfaces. Hence also its arched form. The great toe is occasionally raised by its own retracted tendon, while the other toes are sometimes flexed upon themselves, in their position of extension. The skin of the plantar surface is wrinkled, and presents a rough callus at the metatarsal extremities. That of the heel, if it no longer touches the ground, becomes smooth and delicate.

Third Degree. As the contraction increases, the extremity of the foot gradually passes beyond the perpendicular. The toes are directed backward, until the dorsal surface is beneath, and plays the part of the sole. At this period, it is rarely uncomplicated with one of the other varieties. The bones yield to the forcible retraction of the muscles, and to the superincumbent weight. The metatarsals are curved backwards, and slightly separated from the cuneiform bones. The ligamentous artic-

ulations of the tarsus become lax, and the astragalus is almost entirely dislocated.

The gastrocnemii, the flexors and extensors of the toes, and the plantar aponeurosis, are concerned in this degree of equinus. Lateral complications involve other muscles. The foot has become greatly distorted. The skin of the sole is thin, while that of the inverted upper surface has become hard and rugous. Flexion and extension are prohibited, and the arched instep exhibits in its cavity the salient and retracted fibres. The toes are often interlaced, the calf much reduced in size, and the knee somewhat flexed.

VARUS.

The turning inward of the foot, is characteristic of this complex form.

In the *first* degree the inner edge of the foot is raised from the ground. In the *second*, the patient walks upon the outer edge, while in the *third*, the sole is directed upwards, and the dorsum fulfils the functions of a plantar surface.

In simple varus, the foot is raised upon its external edge, while the sole, looking inwards, is directed forwards and backwards. It is rare. Guerin observed but seven cases in four hundred club feet ; or less than two in one hundred.[1] It is more frequently complicated with equinus ; which has led the same

[1] Mem. sur. les Difform. du Corps Humain. Paris, 1843, p. 320.

author to make the divisions of *varus*, *varus equinus*, and *equinus varus*, as the one or the other variety predominates; each of the two last being subdivided into three degrees. The inward inclination of the foot, is sometimes due to the unaided action of the gastrocnemii, but more commonly results from the traction of other muscles.

The distortion of the skeleton may be resolved into two elements; *adduction* and *extension*.

Adduction. The astragalus forms a centre, for the movements of the calcaneum and scaphoid bones. The cuboid moves upon the calcaneum, the cuneiform upon the scaphoid, while the toes follow the cuneiform in their progress inward. The calcaneum presents its inferior face to the opposite foot, but its attachments to the astragalus undergo little modification. The cuboid is carried inward with the scaphoid, and exposes a small portion of the surface by which it is articulated with the calcaneum. The scaphoid undergoes a more considerable displacement. It is even partially dislocated. Passing inside the head of the astragalus, and descending from its upper part, its position is oblique. The head of the astragalus, at its external and upper part, is salient beneath the integuments, while a new articulation is formed upon its internal surface.

Extension. The pulley glides through its socket, and is exposed in front of the tibia and fibula. A number of new articulations result from this forced extension. The scaphoid, at its superior internal

part, comes in contact with the internal malleolus. Behind, the tibia, and finally the fibula, are articulated to the calcaneum. The displaced articular surfaces become gradually ossified. The head of the astragalus is depressed internally, and the anterior facette of the calcaneum, absorbed upon its internal surface, becomes oblique.

The walk, in varus, is difficult. In the exaggerated form, the patient often requires a crutch or cane. The skin of the dorsal surface, before it acquires a power of resistance, often takes on inflammatory action at its point of contact with the ground. The knees are inclined inward, and the affected foot swings over its fellow, or describes curves to avoid it. The muscular action is complicated. The elevation of the heel is due to the muscles of the calf. The chief agents of adduction are the tibiales, posticus, and anticus. As the foot deviates inward, the tendo-Achillis begins to act in the chord of the arc described by the leg and heel, and exerts an important influence in adduction. The flexor of the great toe now begins to draw, and the foot yielding to the combined action of this muscle and the flexors of the sole, curves upon itself. In other cases, the common flexor of the toes, and the adductor of the great toe, are retracted, and both the flexors and extensors of the foot, acting as adductors, from the change in the direction of their insertions, promote the distortion. The curve of the foot is aided, in this position, by the retraction of its dorsal muscles and the plantar aponeurosis,

while the tension of the long peroneal, compresses it laterally.

In its later stages, this variety yields with difficulty to surgical treatment. The relations of the bones are much altered, and the shape of the foot is sometimes little modified after section of the tendons. In cases of extreme distortion the foot resembles a huge fist. The toes are flexed and interlaced, and the dorsal surface, if in contact with the ground, is occupied by a rough callus. Large and remarkable bursæ are sometimes found under the cuboid bone, when the deformity has existed for a series of years.[1] The now delicate skin of the sole is much wrinkled; the leg is more or less atrophied, and often permanently flexed upon the thigh.

VALGUS.

This form, in which the sole is turned outward, is opposed to varus.

The *first* degree, is what has been called *flat foot*, and is characterized by obliteration of the arch, with occasional retraction of the extensors of the toes.

In the *second* degree, the sole is raised from the ground, and the weight of the body is thrown upon the inside of the foot.

The *third* presents different characters, due to the retraction of different muscles. The relations

[1] Liston on diseases of the Bursae. Lancet, Oct. 21, 1843.

of the bones of the tarsus and metatarsus are altered.

First degree. The skeleton is little modified. The ligaments and muscles which unite the extremities of the arched sole, are relaxed, while in some cases, the retraction of the extensors aid in elevating its anterior extremity. The foot is closely applied to the ground, and rotated outward.

Second degree. The astragalus is partially luxated backward, and the cuboid and scaphoid displaced externally. The peroneals and extensors of the toes raise the outer border of the foot, the anterior part of which is carried upward and outward, the toes being elevated by their extensors.

Third degree. The scaphoid sometimes abandons the internal surface of the head of the astragalus, which then becomes inarticular. The bones of the tarsus separate one from another, yielding to the retracted muscles. The peroneals, the extensors of the toes, the abductor of the little toe, and the accessory muscles are retracted. The metatarsals sometimes leave the anterior articulating facets of the cuneiform, to take a position upon their superior surface, at an acute angle with the leg.

If the tendo-Achillis be also contracted, the patient walks upon the central portion of the sole, with the heel and toes raised. In this exaggerated form, a small surface is applied to the ground, and the skin not unfrequently becomes inflamed and ulcerated. The form of the foot varies with the permanent forces applied to it.

It is difficult to imagine that the unaided muscles of the external surface of the leg, should overpower the force exerted by those of the inner side. Guerin affirms that a pronounced valgus is an indication of a more or less complete paralysis of the gastrocnemii, tibiales, and flexor of the toes. Mr. Little suggests that another reason for the greater frequency of varus, is the fact that the flexors and adductors are earlier developed in the fœtal state, than the extensors and abductors.

TALUS.

Talus is a name applied to a rare deformity nearly allied to the last, and directly opposed to equinus. The foot is in forced flexion; and the pulley exposed posteriorly. The retracted muscles are those of the anterior part of the leg and dorsum of the foot. According to Guerin, this affection also implies a paralysis of the antagonizing muscles. The toes are in contact with the front of the leg, and the weight of the body is thrown upon the heel.

In all these forms, the original distortion is rather due to the muscles than to the aponeuroses and ligaments, which undergo subsequent retraction.

TREATMENT WITHOUT SECTION OF TENDONS.

Before the introduction of the subcutaneous operation, it was common to treat club-foot by the unaided force of machines. Although this princi-

ple is still maintained by certain orthopedists, it cannot be deduced from a scientific consideration of the subject. It is now a well established fact, that in certain cases of distortion, the tissue of the shortened muscles undergoes a fibrous transformation; and it is highly probable if not equally certain, that this transformation is in proportion to the degree of tension to which the muscular substance has been subjected. In an old case of varus, for example, the leg and foot form a sort of bent bow, of which the extremities are united by a cord of fibrous tissue, which at once becomes tense, when an attempt is made to straighten the limb. It seems obvious, that the first step towards straightening the bow, is to sever the string which aids in keeping it flexed; and this treatment is in fact indicated, unless it can be shown, either that the operation is attended with danger or inconvenience to the patient, or that unaided mechanical treatment is equally efficacious.

Now it is well known that the subcutaneous division of a tendon, when properly performed, is attended with trifling pain, and that there is little or no chance of subsequent inflammatory accidents. On the other hand, very severe pain often accompanies the attempt to elongate a retracted tendon by simple extension. And while few at the present day will dispute, that the time occupied by this process is much longer, the deformity is liable to re-appear at a subsequent period.

It is not here implied that all cases of distortion demand an indiscriminate division of tendons. On

the contrary, there are certain cases of recent deformity, and of disease originating in the joint and not in the muscles, where the tenotome may not be required. In such cases the surgeon should be guided by a knowledge of the original lesion and its effects. If, however, a single rule were required, applicable in a large majority of cases, it should be the following: *When in distortion of long standing, while a certain degree of motion still remains in the joint, a tendon evidently hinders the limb from assuming a normal position, it should be divided.*

Upon this subject *Bonnet* (de Lyon) thus remarks:[1] "Among children it is often possible to cure club-feet by machines alone, by friction, etc.; but as, in easy cases, the section of the tendons insures success, abridges the treatment, and avoids pain; as it is, besides, perfectly innocent, I believe that recourse should always be had to it, unless children are to be treated during the first months which follow their birth. It is then so easy to bring the foot into the normal position, that friction and machines, which, at a more advanced period of life, are only accessories of treatment, are then its principal feature, and are alone adequate to produce the desired effect."

The same distinction is made by *Guerin*, between the treatment of the conditions of *contraction* and *retraction*.[2]

[1] Traitè des Sections Tendineuses, etc. Paris, 1841, p. 567.

[2] Vues Generales, &c. Paris, 1840, p. 73.

"Simple *contraction* permits us to hope for the immediate elongation of the muscles, by means proper to effect it; extension, kneading, (*massage*) frictions, &c.; while veritable *retraction*, shortening with fibrous degeneration, implies the impossibility of a return of the muscles to a normal length, or the impossibility of a sufficient mechanical elongation, and demands in consequence the aid of a cutting instrument. Thus, recent deformities by *contraction*, torticollis, flexion of the limbs, may be often successfully treated by mechanical and medical agents, while old deformities by *retraction* demand, peremptorily, surgical means."

For simple mechanical treatment, different methods have been devised.

In the apparatus of *Venel* the action is lateral. In *varus*, for example, upon the external side of the leg, and the internal surfaces of the foot and heel.

Delpech employed two machines; the first, to bring the foot straight, the second, to attain the horizontal position.

Dieffenbach and *Guerin* have employed *plaster* for the same purpose. The foot placed in a box, is brought as far as possible towards a normal position, and covered with plaster, which is allowed to set. It is subsequently renewed at intervals of two or three weeks. A small hole broken in the mass, exhibits the condition of the tissues during treatment. *Guerin* especially recommends this method, when the delicate and irritable skin of young subjects, refuses to submit to the pressure of bandages.

The force is equally distributed, while the cuticle is softened by the retained transpiration.

Mechanical aid is occasionally useful, for the purpose of rendering the tendon tense and salient before section. The apparatus requires continued care, and frequent re-application, especially in infants, where the tissues, compressed by the straps, diminish in volume, and the foot becomes loose.

SECTION OF TENDONS IN CLUB-FOOT.

Different varieties of the deformity demand the section of different fibrous fasciculi.

For the elevation of the heel, the tendo Achillis. For the foot raised upon its outer edge, the tibialis anticus; turned upon its internal edge, the peroneus tertius, and all or part of the extensors of the toes. For adduction, the tibialis posticus, for abduction, the peronei longus and brevis.

For the curvature of its internal border, the adductor of the great toe. For the permanent flexion and extension of the toes, their corresponding muscles, both long and short. And finally, when accessory to the distortion, the plantar aponeurosis, and any of the tendinous and muscular fibres of the foot and leg.

For the different varieties of the distortion, M. Guerin has commonly divided the tendons as follows. For *equinus*, the tendo Achillis, and sometimes the flexor proprius of the great toe. For pure *varus*, the tendo Achillis, and tibialis posticus.

For *varus-equinus*, the tibiales anticus and posticus, the tendo Achillis, the extensor proprius and adductor of the great toe, and sometimes the peroneus longus. For *valgus*, the peroneus tertius, and the longus and brevis. For *talus*, the tibialis anticus, the peroneus tertius and the common extensor of the toes. And finally, the plantar aponeurosis; and other muscles, in less common varieties.

Before the volume of Bonnet, (de Lyon,) published in 1841, I believe no writer had minutely described the manner of dividing the different tendons of the leg. Operations upon the tendo Achillis and tibialis anticus, were already the subject of various memoirs; but the tibialis posticus, and the peroneals of the ancle, had not at that time been divided upon the living subject, although their position was indicated by Velpeau, with a view to their section. Duval in his second edition published in 1843, gives certain details upon this point.

The manual of the subcutaneous operation has been before indicated in general terms. The tendon is made salient if possible. A fold of skin being pinched up at one end, between the thumb and finger of the operator's left hand, the other end is confided to an aid, and the tenotome introduced by a simple puncture at its base. The fold is released that the puncture may recede to a distance from the point of section, and the tendon is divided by a sawing motion.

Tendo Achillis. The patient commonly lies upon

the belly, though Dieffenbach prefers a kneeling position.

The place of section is of importance. Duval and some other writers, merely indicate a point an inch or two above the calcaneum. The distance evidently varies with the dimensions of the limb, and certain other considerations, but as a general rule, the most salient point should be preferred. While the muscular fibres are to be avoided, above, the want of vitality in the tissues forbids a section too near the bone of the heel.

When the tendon is contracted, it sometimes approaches the posterior tibial artery and veins, which we avoid in receding from the heel.

Scoutetten describes a *bursa mucosa* near the calcaneum, the puncture of which might liberate the synovial secretion, in sufficient quantity to interfere with re-union of the tendon.

Authorities are divided upon the direction of the section. Stromeyer, Scoutetten, Duval, cut from the bone towards the surface; while Bouvier, Dieffenbach, Guerin, and many other surgeons, enter the knife beneath the integuments, and incise toward the bone. It is, in general, a matter of little importance whether the section be commenced upon the anterior or posterior surface of the tendon. When, however, the tendon so nearly approaches the posterior tibial artery, with its accompanying veins and nerve, that it is difficult to engage it alone upon the blade, it is evidently bet-

ter to cut toward the bone, that the edge may repel the yielding vessels.

If a pointed tenotome be employed, it should be hindered from piercing the integuments of the opposite surface. The safest plan is to employ a blunt tenotome, a puncture being first made with a lancet or pointed knife.

Most surgeons prefer to make this aperture upon the inside of the heel; a preference for which no strong reason is offered. The integuments are somewhat more lax, and the tendon is occasionally more voluminous, upon that side, while the slender tendon of the plantaris is there more directly beneath the instrument.

A fold of the integument being pinched up, and the tenotome being introduced at its base, the foot is extended by the operator, and the tendon, when tense, severed by an alternate movement of the blade. The moment of section is accompanied with a noise, and with the separation of the extremities in most cases, although the bones are sometimes so distorted, or other tendons so retracted, that this separation is inconsiderable. The air being carefully excluded, and the blood expelled, as far as practicable, the wound is closed with adhesive plaster.

The division of other tendons may precede or follow that of the tendo Achillis. Velpeau divides, in the same operation, all the retracted tendons. Phillips, Duval and others, seek to reduce the complicated varieties of the deformity to the simple

form of equinus, for which the tendo Achillis is subsequently divided. Both methods recommend themselves by their results, but the latter is more generally adopted.

Tibialis Anticus. This muscle is best divided at its most salient point, a few lines below the annular ligament. Beneath, is the articulation of the astragalus with the tibia and fibula, which might be endangered by too deep a section. M. Bonnet asserts that the division of the tendon of the heel often relaxes this tendon, and obviates the necessity of its section.

Tibialis Posticus. Certain cases of exaggerated distortion, have been supposed to demand the section of this tendon, though the operation is comparatively rare, and of difficult execution. Behind the tibia, it is enclosed in a sheath, in the neighborhood of an artery of considerable size. Some anatomical knowledge is required to reach its position below the ankle, since it is rarely salient, and its section is unattended with perceptible separation of its extremities. In cases of complicated equinus, when the scaphoid is at a distance from the external malleolus, the following method of M. Bonnet may be adopted. The eminence of the head of the scaphoid being found, the tenotome is entered at a quarter of an inch above, and a little in front of it, and advanced till it meets the astragalus. The instrument is then slid along against the bone, until its extremity arrives at a point four or five lines beneath the prominence of

the scaphoid. If the edge of the tenotome be now raised until it reaches the skin, the tendon is with certainty divided. This method is inapplicable in the more marked degrees of varus.

The extensors of the toes should be severed at their most prominent point, commonly at the articulation of the metatarsals with the phalanges.

Peronei longus and brevis. These tendons are enclosed in a fibrous sheath, above or below which they may be divided. Above, they are occasionally quite prominent. The position to be chosen below, is about half an inch in front of the ankle, and as was indicated for the tibialis posticus. The surest method consists in introducing the pointed tenotome behind the tendon, and cutting from within outward. This point less endangers the articulation, and allows the instrument to pass free of a protuberance situated upon the external side of the calcaneum.

Flexor communis and flexor longus pollicis: The depth of these tendons renders their section difficult, elsewhere than on a line with the first phalanges of the toes.

The blade is slid beneath, and advanced to the surface. The short flexors may be included in the section.

The *Plantar Aponeurosis* is often retracted, and requires division. The tenotome should be introduced at the inner edge of the foot, where the fibres are in strong relief; commonly at a point near the articulation of the first with the second

range of the tarsus. The section should not be carried so deep as to wound the articulation. This is perhaps the most painful of these operations.

The narrow blade being carefully withdrawn without enlarging the puncture, the blood and any accidental bubble of air are expressed. The finger is kept upon the wound, until a bit of adhesive plaster is made ready and applied, so as hermetically to seal the orifice.

The foot may be then enveloped for an hour or two with a wet compress, which relieves a local burning pain, sometimes experienced by the patient.

A re-division of the tendon is occasionally required during the mechanical treatment, and is indicated by the resistance and prominence of the tendon.

In this way the tendo Achillis has been unjustifiably divided, upwards of twenty times upon the same individual.

A twice or thrice repeated section is not uncommon, nor is it objectionable.

The new division should be effected a short distance above the cicatrix, which occupies the position of the previous section.

MECHANICAL TREATMENT.

It has been a question, whether force should be immediately applied after the section of tendons, or whether it should be delayed to a subsequent period. Velpeau gives preference to immediate mechanical

treatment. Duval, while he recommends the foot to be at once placed in a machine, to retain any advantage that may have been gained by the section alone, deprecates immediate extension. I believe that many of the inflammatory accidents so frequently reported as results of tenotomy, are to be attributed to a too hasty application of force. It may be asserted that a large majority of European orthopedic surgeons, follow the example of Stromeyer, and wait for the cicatrization of the puncture, before applying extension to the limb. In this country, this practice was recommended by Dr. Hayward,[1] of Boston, as long since as 1841.

At the end of forty-eight, seventy-two hours, or even a much longer period, when the integuments are united, and the tendon has set up a restorative process, force may be gently applied.

The adjustment of a machine requires much immediate and subsequent care. A gradual and long continued force, alone will induce the foot to resume its normal position. The foot is unequally covered with tissues, and a slight pressure, even of a strap, a lump of cotton, or a fold of bandage, becomes painful where the bone projects. This is especially true of thin subjects.

The pain is in general dull, though sometimes insupportable. In *equinus* the great toe and instep are more frequently the seat of pain, while in the treatment of varus it occupies the external

[1] Bost. Med. and Surg. Journal, 1841, p. 313.

border of the foot; is lancinating, and exacerbated by the warmth of the bed.

If the pressure be continued, the skin becomes red, hot, and exhibits a gangrenous vesicle, followed by slough and ulceration. At other times the foot is much swelled, while the limb, especially in scrofulous subjects, becomes more or less œdematous.

When the pain is local and permanent, the apparatus should be removed, and the skin, if red, soothed with emollient and narcotic lotions. At the end of a few hours, the machine may be reapplied, the spot being well protected with cotton. In case of an eschar, the ulcer should be allowed to heal, before any attempt to re-commence mechanical treatment.

The first application of a machine is always ineffectual. The tissues require time to accustom and adapt themselves to their new position. They are impatient of force, or are so depressed, that the foot becomes loose in the machine. When it is necessary to change the apparatus, it is important to maintain the foot in its new position during the process. If allowed to escape from the hand for a moment, it tends to resume its recent form, a movement accompanied with great pain. The part should be kept cool. During the first ten or twelve days, it is well to examine the apparatus once or twice a day. It is better also to increase extension in the morning rather than the evening, when the consequent pain sometimes hinders the

patient from sleeping. A want of attention to these details may involve the necessity of suspending the treatment, when the progress of several days is sometimes lost in a short time.

MACHINES.

It remains to describe some of the principal machines, employed in the treatment of club-foot. The principles and aim of most of them are the same. They offer different mechanical combinations, which belong rather to the mechanician than the surgeon. It is this peculiarity, together with assiduous care required in the use of the apparatus, which has led to the establishment of institutions devoted to the treatment of deformity, and has created a class of specialists known as *orthopedists*.

The machines may be described as consisting of a series of pieces, each adapted to a corresponding detached portion of the skeleton, and united by joints, the movements of which represent those of the articulations.

The apparatus should be capable of conforming itself to the curve of the distorted limb, and is provided with screws, or other mechanical contrivances, for forcibly restoring the parts to a normal position. (figs. 16, 17, 18.)

EQUINUS.

When the deviation is slight, it suffices, after section of the tendons, to confine the foot in a com-

mon boot, the leg of which is of stiff cowhide, and laced in front. The starched bandage is also employed with success for this purpose.

If the distortion is great, these methods are insufficient, and it becomes necessary to employ a certain amount of force. The machine of Stromeyer, and the boot of Scarpa, may be regarded as the type of such apparatus, and have undergone various modifications.

The Machine of Stromeyer, (fig. 14,) employed by Dieffenbach, consists of two bars of wood, extending from the ham to the ancle, on each side of the leg, and united by cross-pieces at top and bottom. A third sliding cross-piece, capable of being fixed by screws, serves as an axis of flexion and extension to a piece of board which corresponds to the sole of the foot. The flexion of this wooden sole is effected by two cords, which, attached to its upper corners, traverse pulleys at the upper part of the parallel bars, and return to a roller governed by a ratchet, at the lower extremity. The calf of the leg rests upon a sheet of leather attached to the parallel bars, and is secured by straps.

Scarpa's Boot, (fig. 15,) which has been modified by Guerin, Phillips, and others, presents a sort of shoe open at top, and united by straps. At the ancle, it is articulated with two lateral uprights of metal, which are bound to the leg at intervals, by wadded straps. The flexion of this joint is governed by a screw fixed by its extremity to the sole, and passing obliquely to one of the metal uprights.

The sole itself is sometimes jointed, and admits of a lateral movement, which accommodates it to the lateral varieties of club-foot. It is governed by a screw upon its edge. [1]

The machine of Stromeyer is possessed of greater force than the boot of Scarpa, while the latter is more portable. The boot, worn to advantage during the day, may be replaced by the machine of Stromeyer at night.

VARUS.

The treatment of varus is more difficult, the resistance of the skeleton in the exaggerated forms, being often great.

In young children, it sometimes suffices to sever the tendo Achillis, and apply subsequently the starched bandage. For older children, the boot of Scarpa may be employed. Phillips, Duval, and Little, prefer, when the deviation is great, to attack the distortion of adduction, and to convert the form of varus into simple equinus, before dividing the tendo Achillis. If this method be adopted, the result may be attained in the following way. The leg, when the punctures are healed, should be enveloped in wadding which is confined by a roller. (fig. 19.) A long splint, morticed at its extremities, is cushioned, and applied to the external surface of the leg, extending from the knee to about six inches

[1] Modifications of these joints will be found in the drawings.

below the heel. The superior extremity is fixed to the head of the fibula by a band, which, after passing through the mortice, is continued around the leg to the heel, and starched. The splint being thus bound to the leg, its lower and projecting extremity serves as a point of attachment to a band, which is fixed by several turns to the end of the foot, and serves to draw it outward. The varus is thus gradually converted into equinus.

An ingenious method of Dieffenbach, (fig. 20,) applies to certain cases of slight deviation. The middle of a yard of starched band, looped round the inside of the heel, crossed on the outer ancle and adhering to the calf, tends to draw the heel outward. A similar loop, not starched, is allowed to hang loose a few inches below the inner ancle and sole, and is bound by a roller to the internal surface of the leg. A long splint, terminated by a lateral notch, which is engaged in this loop, is now bound to the external surface, as high as the knee; and the apparatus is complete. It will be observed, that the splint acts as a lever over the outer ancle, which serves as its fulcrum, to draw the sole outward, by means of the loop round its extremity. If the patient walks, the splint is driven upwards and outwards, and the foot necessarily follows it.

Among the machines which conform to the deviation of the foot, that of Bouvier and Duval may be mentioned.

The Machine of Bouvier consists of a jointed sandal attached to a lever, which, acting over the

ancle, carries the foot outward, as its superior extremity approaches the leg.

The Apparatus of Duval, (figs. 22, 23,) is complicated in appearance; but is little more than the sandal of Scarpa's boot, attached by a universal joint to a leg-piece. The joint is governed by two perpetual screws. An upright, which extends from the inner side of the sole to the ancle, is furnished with a cushioned metal plate, which may be advanced against the heel by screws behind it. (fig. 22, *b*.)

The apparatus of *Little* is taken from the Lancet, Feb. 24, 1844, and will be readily understood from the drawing. (fig. 21.)

VALGUS.

In the simpler forms of valgus, a starched bandage sometimes suffices, after section of the tendo Achillis. If complicated, the splint may be used to reduce it to the form of equinus, as was indicated for varus. The splint should here be applied on the internal surface of the leg.

OTHER METHODS.

The treatment of club-foot by means of a plaster mould has been already alluded to. In the less exaggerated varieties of distortion, and especially in children, the foot may be gradually brought down by a sole, or sort of shoe, attached to bands of wrought iron, so thin as to allow of being bent

to the required position, and stiff enough to retain it.

While the common expedients of mechanical treatment have been described, it is obvious that its purpose may be equally effected by a variety of combinations, the details of which are here unnecessary.

GENERAL REMARKS.

Before submitting the limb to the action of a machine, especially of the more powerful ones, it is of great importance that it should be adequately protected. It should be enveloped in a soft roller, and afterwards covered with cotton, especially at the points of puncture. The salient parts being then wadded, and the cavities carefully filled, the cotton should be kept in place by another roller. Any fold or inequality is now to be arranged, and the whole covered with a stocking. The limb thus swathed is placed in the machine, carefully surrounded with cotton, and the straps successively fastened. In general the apparatus should be at first loosely applied. As the foot becomes accustomed to pressure, the straps may be drawn tighter, while the force is gently augmented. When the patient complains of pain, relief is sometimes afforded by loosening the straps and inserting fresh wadding. A continuance of the pain, demands that the foot should be removed from the apparatus, and the skin exposed, with a view to the local treatment elsewhere described.

TORTICOLLIS.

The division of the sterno-cleido-mastoid muscle with the adjacent integuments, was performed by surgeons of the last two centuries.

The operation by a simple puncture is of more recent date. *Dupuytren* practised this method in 1822; and in 1826 and 1830, *Stromeyer* and *Dieffenbach* published similar observations of their own. In France, the method was reproduced by *Amussat*, *Bouvier* and *Guerin*, in the years 1836, '37 and '38. The latter writer has since materially modified the operation, and has thrown much light upon the affection for which it is practised.

CAUSES.

The agents of this distortion may be considered in two classes. The one including the varieties in which the contraction or retraction of the sterno-cleido-mastoid muscle, is the chief source of the

affection, while to the other are referred all other causes. To the former, the operation about to be considered, is in most cases applicable; to the latter, much less frequently.

1. Among this class are A. caries of the bone; indicated especially by the history of the lesion.

B. An inflammation of the synovial capsules and fibrous tissues of the cervical vertebræ, which Bouvier has called *articular torticollis*. It is either acute or chronic. Distortion results from the long continued efforts of the patient, to relieve the tense and painful ligaments, by displacing them in a direction which the head ultimately retains.

C. Abscesses and cicatrices in the cervical region.

D. Tumors and glandular engorgements, so considerable as to force the head for a length of time from its normal position. To this last class Duval attributes thirty out of [1] sixty cases treated by himself, in which the disease was followed in two or three months, by permanent shortening of the muscles.

E. Paralysis of the muscles of one side, the head yielding to the unantagonized force exerted by the opposite side. The cervical column is not curved, but the last cervical is inclined upon the first dorsal vertebra. In efforts to bow the head, the chin flies to the paralyzed side. In this form, the distortion, if exaggerated, may be partially relieved by a section of the healthy muscle.

[1] Op. cit., p. 513.

2. The principal causes which directly affect the muscle are,

A. Active muscular contraction, with subsequent retraction, atrophy and fibrous transformation. To this agent, most cases of congenital torticollis are due.

B. Muscular rheumatism of the sterno-cleido-mastoid muscle, and the retraction which may result from it.

C. The action of forceps during labor. The muscle is torn, and blood effused, much as when subcutaneously divided. Simple contusion sometimes suffices to produce inflammation, followed by retraction.

The deviation is more frequent to the right than to the left. According to Phillips, two-thirds of the cases of this distortion due to muscular contraction, are directed to this side; and in connection with the last cause of the lesion, it is affirmed that in seventy per cent of ordinary labors, the head is presented in the first position.

The form of torticollis, about to be considered, recognises muscular retraction as its immediate cause. The muscles are either idiopathically affected, or are retracted at a period subsequent to the original lesion; so that the head, for a length of time displaced, by glandular enlargement or otherwise, is retained in its abnormal position by the muscular fibres, which accommodate themselves to their new relations.

SYMPTOMS.

The head deviates in various degrees, to the right or left of the normal position. In the exaggerated forms, the chin is raised in the air, while the head is rotated, and depressed upon the shoulder of the affected side. In this situation the face changes its expression; the features of the depressed side become in a measure atrophied; the brow falls and the cheek becomes less prominent.

In the region of the sterno-cleido-mastoid muscle, a dense cord is felt, which becomes more prominent and resisting, if force be applied to the head in a direction opposed to its action.

The shoulder of the contracted side is drawn upward and forward, so that the sternum and the centre of the thorax, being no longer upon the same plane with the shoulder, are apparently depressed. Much pain with a sensation of dragging, is sometimes experienced in the affected side, increased by atmospheric influences, after exertion, and in bed.

STERNO-CLEIDO-MASTOID MUSCLE.

M. Guerin considers this a double muscle, of which the two parts, endowed with different functions, may be separately affected.

The following are his propositions: [1]

[1] Memoire sur une Nouvelle Methode de Traitement du Torticolis ancien, Paris, 1843, p. 186.

1. The sterno-cleido-mastoideus consists of two distinct muscles, the sterno-mastoideus and the cleido-mastoideus.

2. The sterno-mastoideus and the cleido-mastoideus are possessed of separate functions. The first is especially a motor of the head, the other is essentially an inspirator muscle.

3. In torticollis, till now attributed to the shortening of the entire sterno-cleido-mastoideus, the sternal portion of the muscle may be alone primitively affected.

4. In the treatment of chronic torticollis, due to the shortening of the sterno-mastoideus, the section of the sternal portion, may suffice for the disappearance of the essential cause of the deformity.

The division of the sternal insertion of the muscle, is in certain cases, followed by a more or less gradual restoration of the head to a normal position. Such cases are reported by Duval and other writers. In other cases it is insufficient, and it is necessary to divide also the clavicular portion. Bonnet[1] remarks that it is far from sufficing in all cases; and that four times out of five, he was compelled to divide at a later period the clavicular fasciculus, before the distortion yielded.

VERTEBRAL COLUMN.

The head being carried out of the centre of gravity, the vertebral column institutes a series of curves

[1] Op. cit., p. 582.

with a view of restoring the equilibrium. They are of two kinds. The first is general, and is due to all the vertebral articulations.

The second, described by Guerin, is local, and occurs at the intervals of the last lumbar vertebra with the sacrum; of the eleventh and twelfth dorsals; and of the seventh cervical and first dorsal. From this inclination of "*locality*," which is an exaggeration of the normal movements of the articulations, results a series of rëentering angles, common to the spines of all subjects affected with chronic torticollis, and continuing after the division of the muscles of the neck.

TREATMENT WITHOUT SECTION.

Before the disease assumes a chronic form, while the muscle is yet in a state of simple contraction, the deformity sometimes yields to medical treatment; such as kneading, alternate flexion and extension, and friction. M. Guerin especially recommends local friction with the tartar-emetic ointment; the developement of the pustules being sometimes simultaneous with the restoration of the head to a normal position.

It should be remarked, that the sterno-mastoid muscle is not the sole cause of distortion in chronic cases. Other cervical muscles participate in the affection, and a prolonged treatment is required to counteract their efforts, even after the division of the fibres of the sterno-mastoid. Neither

is the exaggerated form of distortion completely relieved by surgical aid. A certain inclination of the head often continues, and the features and facial bones, atrophied upon the depressed side, rarely regain their normal outline.

The age of the patient is another important consideration. M. Bonnet places the limit at fifteen years; after which a perfect restoration of the parts, in the chronic form of the lesion, can no longer be expected.

SECTION OF THE STERNO-CLEIDO-MASTOID MUSCLE.

Before the adoption of the subcutaneous operation, it was common to divide the integuments transversely; after which the muscular fibres were severed, layer by layer. Such was the operation practised by Brodie, Warren, Roux, and others. Of late years the subcutaneous method has been generally adopted.

Although the section of one, commonly of the sternal insertion, sometimes suffices, it is often necessary to divide both tendons. Guerin, who for a time sustained the former theory, has since divided, in many cases, both fasciculi.

It is usual first to attack the more prominent of the two tendons, after which the other becomes more tense and may be divided either immediately, or at an interval of a few days, as suggested by Bonnet. In certain cases the muscle may be divided at once.

There has been much discussion upon the merits of different sections. It has been doubted, whether the puncture should be made from within outward, and the section from the profound to the superficial parts, or vice versâ ; and much unnecessary importance has been attached to these differences.

As a general rule, the point of section is at a short distance above the sternum. Guerin gives the distance of six or eight lines ; Phillips an inch ; Duval half or three-quarters of an inch. This length evidently varies in different subjects.

It occasionally happens that the tendon makes no prominence near the clavicle, and it becomes necessary to divide it at its most salient point, two or three inches above. The hemorrhage which follows a muscular section is sufficient reason for proscribing this point when it can be avoided. The section of the superior extremity, has long since been abandoned.

The following are the principal methods :

Method of Dieffenbach. The patient being seated, an aid behind draws the head to the side opposed to the deviation, while a second aid depresses the elbow and shoulder of the affected side. The muscle being thus made tense, the operator pinches it up between his thumb and finger, and passes beneath it, at a short distance above the sternum, a small curved bistoury. When the point is felt beneath the skin of the opposite side, the knife is

slowly withdrawn, and the muscle being pressed against its edge, is in this way severed.

Duval's Method. The patient is placed in the position just indicated, and the tendon made salient. The tenotome is introduced at its posterior surface, for the sternal insertion, from within outwards. In this case, the surgeon being in front of his patient, the right hand is employed for the right muscle, and the left hand for the left. For the clavicular insertion, the knife is introduced behind the most salient edge, whether external or internal, and the tendon is divided, from the deep to the superficial layers. When the tendinous fasciculus is not marked beneath the skin, a puncture is made with a lancet, by which a blunt tenotome is carried to the opposite border of the muscle.

On three occasions, M. Duval divided the whole muscle, by the aid of a single puncture at the internal border of the sternal insertion; and once, by a puncture at the external border of the clavicular extremity.

Guerin's Methods. Sterno-mastoid. 1. The patient lies upon a bed, the upper part of which is elevated. An aid draws the head, so as at once to oppose the inclination, and exaggerate the existing rotation. In this way the muscle is extended, and by the last movement carried into an anterior plane; detached as it were from the subjacent parts. A fold is raised parallel with the muscle, and the tenotome introduced flatwise, beneath the skin, at a point corresponding, when the skin is relaxed, with

the external border of the muscle, and six or eight lines above its insertion. The fold is released, and the edge previously turned upward is pressed upon the muscle, which is divided. The tenotome here employed, is peculiar, and concave upon the edge. (fig. 12.)

2. In the second method, less effectual than the last, and less employed, a convex tenotome is introduced beneath the tendon. A grooved director is here objected to, upon the ground that it traverses the tissues with difficulty.

Cleido-mastoid. The muscle being put in tension, and a fold raised, the instrument is introduced upon its inner border, eight lines above its insertion, and the division is effected from the skin towards the centre ; so that the two insertions may be successively severed in opposite directions by means of a single puncture in their interval.

There is little danger of wounding the larger vessels, especially in the methods of Guerin. It has been shown how the muscle is carried into a plane anterior to these vessels. By making the puncture near the clavicle, we avoid the anterior jugular vein in its passage to the subclavian. The primitive carotid-artery and internal jugular vein are protected by the sterno-hyoid and sterno-thyroid muscles, and correspond in both sections to the base of the blade of the knife. In dividing the cleido-mastoid, the anterior jugular, when it exists, may be left between the back of the instrument and the skin, if the knife be introduced in a position per-

pendicular to the muscular fibres, and not flatwise.

Should a second section become necessary at a subsequent period, certain precautions are requisite. The adhesive action and subsequent cicatrix may displace the larger vessels, and Duval suggests, that an interval of six months should be allowed to elapse, before the section is repeated, in order that the newly formed substance may completely insulate itself from the surrounding parts.

The complete division of the muscle, in all these methods, is attended with a slight explosion, deepened by the proximity of the chest, and also by a sudden separation of the two ends of the divided muscle, and a corresponding movement of the head. As soon as the knife is withdrawn, the blood is to be expressed from the wound, and the puncture hermetically sealed with a bit of adhesive plaster of the size of a shilling. A compress and roller complete the dressing. Great care is requisite to prevent the admission of air into the wound. Pus in this region sometimes infiltrates the anterior mediastinum. Once formed, the pus should be allowed to escape; although when fluctuation is just perceptible, compression sometimes favors the absorption of the fluid. For this purpose, a ball of lint is placed upon the tumor, and being covered with compresses, is maintained by long strips of adhesive plaster, extending from the back upon the chest.

With a little attention however to diet and repose, espscially if the air has been excluded from the

wound, these accidents are avoided. The wound commonly heals by the third day, and mechanical treatment may be then commenced.

SECTION OF OTHER MUSCLES.

The division of the sterno-cleido-mastoid muscle sometimes relieves the deformity but incompletely. It is then important to ascertain whether other muscular fibres aid in retaining the head in its anormal position ; in which case they become tense, oppose any effort to replace the head, and require division. Portions of the trapezius, and platysma have been thus divided.

MECHANICAL TREATMENT.

The aim of mechanical treatment is twofold. 1. To adjust the head in a normal position. 2. To correct the curves of the vertebral column.

When the deformity is slight, the spinal distortion is also inconsiderable, and attention should be chiefly directed to the position of the head upon the cervical vertebræ. In older patients, and in the exaggerated varieties, it becomes necessary to apply force to the vertebræ, both in the cervical and dorsal regions. The apparatus is then complicated.

Among the more simple means of commanding the head, are the following:

1. A cravat of pasteboard, or boiled leather, as employed by Guerin, is simple, and almost univer-

sally adopted in ordinary cases. Its height may vary at different points. A substitute is a circle of stiff wire, so bent as to correspond with the edges of such a cravat.

2. A band carried around the head horizontally and united to vertical bands over the crown from before backward, and from ear to ear. A band fastened to the first, at the mastoid process of the healthy side, is drawn down in front and attached upon the chest or at the waist, so as to aid the action of the healthy muscle. A cap may be substituted for the bands upon the head.

3. The temporo-axillary bandage of Mayor. The base of a triangular handkerchief is applied to the temple of the affected side, and the extremities brought, one round the forehead, the other round the occiput, to be united below the axilla of the sound side. A horizontal band may be added to this bandage.

The two last methods tend rather to increase than diminish the cervical inclination, and are therefore only applicable in slight deviation, or as temporary substitutes for other apparatus.

A complete machine, the force of which is adapted as well to the spine as the head, is complicated and expensive. Various models have at different times been contrived for this purpose. They are adapted either to the horizontal or upright position. The former have received the name of orthopedic beds, and are chiefly modifications of those of Shaw and of Guerin.

The apparatus which admits of locomotion recognises its leading features in the *Minerva* of Delacroix, and takes its point of counter extension upon the pelvis or the shoulders.

The Apparatus of Bouvier, modified from the *Minerva*, consists of a wide metallic belt resting upon the hips and haunches. To this is fastened a steel upright in the form of a T, which occupies the region of the spine and scapulæ, and is retained by shoulder-straps. A firm point of counter-extension is thus obtained between the shoulders, to which is attached an upright bar, from which the head is suspended.

The head is secured by a horizontal metallic band, descending upon the mastoid processes, which gives attachment to vertical straps for the crown and chin. The iron rod by which it is attached to the steel plate between the shoulders, is so contrived as to admit of elongation, extension, flexion, rotation, and lateral inclination, in any of which positions it may be fixed. (fig. 24.)

Cravat of Phillips. A large triangular piece of sheet iron, well cushioned, is adapted to the back of the chest, the base corresponding to the shoulders. A strap secures it around the hips. The chief support is derived from broad wadded suspenders, which secure it over the shoulders. To this triangle is fastened an upright of iron, capable of being raised or depressed, and terminated above by a tooth, corresponding in position, and use, to the odontoid process. Upon this rotates, by means of a

socket, a stuffed collar of iron which supports the chin. This contrivance is cheap and effectual. (figs. 25, 27.)

The orthopedic bed of Guerin is modified from that of Shaw. It consists of the divided bed, of which the superior point of division corresponds to the union of the cervical and dorsal regions, instead of corresponding to the central dorsal region, as in that employed for lateral curvature of the spine. (figs. 31, 34.) The body is secured upon the bed, and appropriate lateral force is applied. The head is confined in a casque, and is secured by a collar adjusted to the chin. The movements of this helmet, which are thus communicated to the head, are universal, and graduated.[1]

An inclined plane, to the head of which the chin is attached, by a handkerchief passing under it, is serviceable in certain cases. Extension is then effected by the weight of the body.

[1] The details of the machinery, obvious to an ingenious mechanist, but requiring a long description, may be found in the last edition of Torticollis, Paris, 1843. I am not persuaded that the mechanism is the simplest and most effectual.

FALSE ANCHYLOSIS OF THE KNEE-JOINT.

The division of tendons is much less effective in deformities of the knee, than in those of the foot. While club-foot depends in a majority of cases upon muscular retraction, without lesion of the synovial surfaces, distortion of the knee rarely originates in this cause. It commonly results from disease, either of the cavity of the joint, or of its investing membranes. Duval refers fifteen cases in twenty to sub-inflammations of this articulation. The change in the form and character of the tissues is then so considerable, as often to render it difficult to restore the normal shape of the limb or its functions. Most cases, however, are susceptible of amelioration from treatment, and it is sometimes possible, both to straighten the limb and to renew its suspended movements.

CAUSES.

Congenital retraction. This variety of the affection is analogous to other congenital deformities, and is accompanied with the fibrous transformation of the retracted muscles. As in the operation for club-foot, their section then facilitates the subsequent mechanical treatment. Muscular retraction materially interferes with the developement of the bones and other parts, in early life; and the limb rarely or never regains its normal length and outline, if the operation be deferred till adult age. As an idiopathic affection of the knee, it is, however, comparatively rare.

Permanent flexion. In this position of the leg, the muscles become, after a time, passively retracted, and require, equally, division. It is unnecessary here to inquire what agents contribute to this position, so common in chronic diseases of this articulation. By the flexion of the knee, most of the muscles are relaxed; it is the natural position when the patient lies on the side, and the necessary one, when the synovial cavity is distended with fluid.

It is also sufficient to know, that in a large majority of cases of long standing, resulting from both these causes, adhesions are formed between the articulating surfaces; and in this connection it is unimportant, whether they presuppose synovial inflammation, or whether, as Hunter supposed, and as seems to follow from the recent investigations of

M. Teissier,[1] a simple state of rest may cause vascularity of the synovial, and the deposit of false membranes.

Serious lesion of the Joint. The most common form of false anchylosis, is that in which the articulating surface is materially altered; where chronic inflammation, ulceration and the lesions commonly accompanied by the white swelling, have occasioned long continued suppuration, cicatrices and change in the form of the cartilaginous and bony extremities.

The following are the principal changes which result from long continued flexion of the joint, in disease of this sort.

PATHOLOGICAL ALTERATIONS OF THE TISSUES AND THEIR CONSEQUENCES.

The entire limb is commonly withered and atrophied.

Spontaneous luxation. The weight of the flexed leg resting upon the heel in a horizontal position, aided by the action of the flexor muscles, incline the head of the tibia backward, and the joint tends to open behind; while the distended condition of the lateral and posterior ligaments finally permit this bone to glide back upon the posterior surface of the condyles of the femur, which are often atrophied at that part.

[1] Gaz. Med. t. ix., p. 609 – 26.

Rotation. The powerful action of the biceps flexor, the shape of the condyles, the disposition of the crucial ligaments, and the position of the leg, which the patient supports upon the outer side of the heel, tend to impress upon it a movement of rotation outward, often considerable. Duval refers to a case in which the internal condyle of the femur was received into the external concave surface of the tibia; there being a semiluxation of the tibia upon the femur. These partial luxations according to Bonnet, accompany three-fourths of the cases of angular anchylosis of the knee.

Outward luxation of the patella generally accompanies rotation of the tibia.

Change of form in the articulating extremities. The parts in contact undergo ulceration and absorption. The pressure of the condyles of the tibia, often ulcerated themselves, occasion extensive absorption of the posterior part of the condyles of the femur, which are sometimes excavated to the depth of half an inch or more. The pressure of the patella upon the external condyle in front, destroys its convexity.

Adhesions. The patella is sometimes glued to the anterior part of the femur, and sometimes to the interval between the femur and tibia, in which case it is impossible to straighten the limb. The cartilages of the anterior part of the femur are sometimes absorbed, and the two bones become intimately united by fibro-cellular bands, in a way to obliterate the anterior half of the cavity of the syno-

vial membrane.[1] Finally, masses of fibrous tissue surround the joint, occupying especially the popliteal region, where they envelope the vessels and nerves, and form a compact mass. A dissection was exhibited by M. Chassaignac to the Anatomical Society of Paris, in which the popliteal artery was so contracted by these adhesions, and imbedded in them, that any attempt at sudden extension of the limb must have produced its rupture.

DIAGNOSIS OF THE DIFFERENT ORGANIC LESIONS.

While the disease is in an active state, besides the constitutional symptoms, the knee is often much enlarged; it may present the peculiar doughy feel which sometimes accompanies sub-inflammatory action in this region, or may be distended with fluid. There is generally more or less pain upon movement, however slight.

When the nerve is retracted, probably by virtue of its fibrous sheath, it is of manifest importance to distinguish it from the tendons, which present a similar elevation in the ham. Their relations, however, are different. While the tendons may be traced to the condyles of the femur, the nerve traverses the area of the popliteal triangle and gains the space between the condyles.

The position of the bones is easily detected. The luxation and rotation of the tibia is indicated by the

[1] Bonnet, p. 560.

corresponding and evident modification of the outline of the limb, and by the outward direction of the toe, when the anterior part of the thigh is made to look directly forward.

The absorption or disintegration of the articulating surfaces is difficult to be detected, and must be inferred from the duration of the disease, the position of the limb and of the patella, and from the amount of suppuration.

The existence of fibrous tissues is to be inferred from the resistance of the soft parts and the cicatrices of fistulous passages.

Adhesions are less difficult to be recognised than ulcerations of the articulating surfaces. The union of the tibia and femur is indicated by the absence of all movement. The adhesion of the patella should not be confounded with its immobility resulting from the tenseness of the ligaments when the leg is flexed. When the patella is adherent, we may always infer the obliteration of the anterior part of the cavity of the joint. [1]

It is however in some cases difficult to distinguish true from false anchylosis; the bony, from the fibrous union of the parts. The pain produced by the forced flexion of the joint is an uncertain test. Perhaps the surest indication that the union is false, is the possibility of still producing a certain amount of flexion beyond the point at which the knee is stationary, and hindered from exten-

[1] Bonnet, p. 571.

sion by the retracted muscles. The limb can then in most cases be straightened. But when the joint is entirely deprived of the power of flexion, it is probable that the anchylosis is bony ; and in such cases even when the osseous deposit is inconsiderable, it is doubtful if the degree of flexion has ever been diminished. It is of less importance to distinguish true anchylosis, imperfect though it be, from the complete fibrous union of the synovial surfaces, which sometimes follows rheumatic affection, since this lesion also offers serious obstacles to mechanical treatment.

Passive flexion of the joint is sometimes diminished or entirely prevented, during the examination of the patient, by the active contraction of the muscles ; so that capability of motion may exist where it is not detected. In such cases, if the attention of the patient be diverted, the muscles become relaxed, and a certain power of movement is found still to exist. As was before stated, it is commonly in the direction of flexion ; extension being prohibited by the passively contracted muscles. In examining the limb, the alternate forced movement, which stimulates the contraction of the muscles, may be replaced, by measuring, as Duval recommends, the distance between the ischium and heel, in each position, the pelvis being fixed. If there is a difference in the measurements, the union is false.

TREATMENT.

The treatment of false anchylosis of the knee-joint, may be considered under three general heads.

1. The division of the tendons which oppose extension.
2. The extension of the limb.
3. The reproduction of its normal movements.

The evidence of the results of treatment is far from satisfactory. Thus, in the serious lesion of the joint already alluded to, Bonnet maintains that the section of tendons is never practised with success; Phillips is less decided as to the efficiency of treatment, while Duval offers numerous observations of distortion from lesion of this sort, accompanied with suppuration and subsequent cicatrices, in which treatment produced a straight and serviceable limb.

The results of these cases seems to have varied, not only with the character and degree of the lesion, but with the nature of the mechanical treatment; and it is therefore important to estimate the value both of the indications for treatment and of the different methods of applying mechanical force.

Of the former, one of the most promising is the possibility of still executing a certain degree of flexion. Duval does not hesitate to affirm, that by means of sub-cutaneous sections, its entire extension can always be obtained, provided the anchylosis is false or incomplete. But it is evident that without the indication afforded by the capability of flexion,

it is difficult, if not impossible, to establish this important point. There is little or no recorded evidence to show that the limb has ever been reduced when the joint was entirely destitute of the power of motion, that is, of flexion ; while on the contrary it frequently happens, that all efforts fail to produce any modification in the outline of the limb. The cavity of the joint has then become the receptacle of organized lymph, which has soldered together the articulating surfaces.[1] In time, this lymph is transformed into bone and the anchylosis is complete.

But it does not theoretically follow, in the absence of facts, that treatment must be unavailing, because there is no movement in the joint, even at a period when the lymph presents some traces of osseous deposit. Nor are the experiments[2] of M. Bonnet upon the dead subject conclusive. The organized false membrane, while endowed with vital properties, must tend to yield to a permanent and proportionate force ; to be relaxed by gradual traction, and to be absorbed by pressure. In this way, continued mechanical force is capable of producing effects upon the living tissues, which the passive resistance of the dead and inert fibres would render impossible. In such cases, experiment alone can

[1] I have examined a knee in this state, in which there was no possibility of producing movement, though as yet no osseous particles had been deposited.

[2] In these attempts to straighten the limb, it was found necessary not only to divide the tendons and fibrous tissues, but also to open the joint behind, in order to allow the posterior edge of the articulating surface of the tibia to recede from the femur. Op. cit., p. 563.

decide upon the propriety or the capabilities of treatment.

Interarticular adhesions are not the only obstacles to the successful treatment of this deformity. An equal, and according to some writers, a greater difficulty exists in the distortion of the articulating surfaces. Nor is the amount of this distortion indicated by the degree of flexion of which the joint is capable; for, as Duval affirms, the joint may enjoy this power to a considerable extent, where the alteration of the articulation is sufficient to interfere materially with treatment. When the luxation is great, and when the condyles are partially absorbed, it sometimes happens that all attempts at extension are fruitless; either because the adhesions are too firm to be overcome, or because the patella has engaged itself between the tibia and femur, and cannot be displaced.[1]

The condition of the articulation also exercises an important influence upon the shape of the limb after treatment. This, however, depends not only upon the degree of luxation and rotation of the tibia, upon the amount of ulceration and absorption of the cartilage and bone, but also upon the direction and adjustment of the mechanical force employed during the treatment.

The tendency of the tibia to backward luxation has been referred to. If in permanent flexion of this sort, an extending force be applied to the foot,

[1] Phillips, Op. cit., p. 201.

the head of the tibia does not glide forward on the condyles of the femur, as in the normal condition of the joint, but tends to remain stationary behind it. The anterior margin of its articulating surface forms, against the femur, a fulcrum by which the posterior edge is gradually lifted away from the condyles; so that when the limb is straight, the perpendicular of the tibia is behind that of the femur, and the weight of the body resting on the femur, bears upon a point anterior to the tibia.

This is the condition of the leg in a large proportion of the cases mentioned by Duval. Mr. Little seems to have obtained better results; the tibia being made to occupy a position more directly beneath the femur. The advantage in the treatment adopted by the latter surgeon, is mainly due to the distribution of force in the machines employed. While that of Duval merely extends the limb, the apparatus used by Little aims both at extension and at the reduction of the head of the tibia; which is lifted into its place, by an effort applied directly to it. In fact, without this arrangement, the previously existing luxation is liable to be exaggerated, and even to be rendered complete.

The degree of movement permitted to the joint after reduction also depends chiefly upon the degree of the lesion, but also partly upon the treatment. In Duval's cases, six patients in ten were left with a stiff joint; but it should be remembered that this surgeon considers the treatment complete, when the limb is brought down and the patient is

able to rest his weight upon it. Little, on the contrary, here commences a third stage of treatment, with the view of re-establishing the movements of the articulation; and he seems, in some cases, to have obtained this desirable result.

When the deformity occurs at an early age especially when it is congenital, and depends upon muscular contraction, it is of great importance not to delay treatment. The retracted muscles prevent the bones from attaining their normal length, and irremediable deformity is the consequence. In May, 1838, M. Bouvier exhibited to the Acad. des Sciences, a specimen which demonstrated these consecutive changes of bones and ligaments, and the necessity of early action to anticipate these alterations.

Duval fixes the average duration of treatment at six weeks, and the maximum at three or four months; while Little places the average in adults at two months; a shorter period being required for children. The process of restoring mobility varies from three months to a year.

MEDICAL TREATMENT.

It is sometimes well to fortify the general health of the patient, who is often of a scrofulous constitution; and also to reduce, if necessary, the local inflammation, before submitting the limb to surgical influences.

Duval recommends for this purpose a course

like the following. Salt-water baths every two days; if practicable, in the open air and sun. Three or four cups daily of infusion of hops, with ten grains of bi-carbonate of soda, or a dozen pastilles of lactate of iron. Claret wine, diluted with infusion of hops at meals. Broiled or roast meat. No milk nor fruits. In short, a tonic and anti-scrofulous regimen.

At night, a poultice to the knee, made with a narcotic decoction.

Every morning, on removing the poultice, friction of the joint with a bit, of the size of a filbert, of the following ointment.

Simple Cerate		ʒ i i
Bromide of Iron		ʒ i i
Extr. Hemlock	aa	ʒ i i i
Camphor		

For the bromide of iron may be substituted eight grains iodine, with a drachm of hydriodate of potassa, if slight irritation of the surface be desired; or ʒ i i of the iodide of lead as a simple resolutive producing no cutaneous irritation.

SURGICAL TREATMENT.

Under this head will be successively considered, 1. Treatment without tenotomy. 2. The section of tendons. 3. Sudden extension. 4. Gradual extension after the inflammatory symptoms have subsided. 5. Tenotomy and extension during the existence of local inflammation.

TREATMENT WITHOUT TENOTOMY.

What has been already said upon this point, in connection with Torticollis and Club-foot, applies equally to False Anchylosis. The resistance of the muscles, when recently contracted, may undoubtedly be overcome by simple extension. According to Little, we may succeed without tenotomy in effectually straightening the limb, in a favorable case of false anchylosis in the adult, after the lapse of five years; but it is rarely possible in a child, unless of very lax fibre, permanently to relieve by mechanical means, a severe contraction of similar duration. The fibrous transformation is more rapidly effected in children; partly because the functions are in general more active, and partly perhaps because the muscle is subjected to increasing tension, as the bones are developed.

THE SECTION OF TENDONS.

The tension of the muscles, and the resistance which they offer to extension, is of course the immediate indication for tenotomy. In the congenital form, tenotomy is especially indicated. When the retraction is only passive, and the sequence of permanent flexion, the duration of the lesion will give some indication of the probable degree of fibrous transformation, and the propriety of tenotomy. In most chronic cases, extension is

facilitated and the treatment is abridged, by dividing the tendons of the ham ; but the more important element of prognosis, the condition of the articulation, must be taken into the estimate, in deciding the question of treatment.

The section of the tendons which oppose the extension of the leg, seems to have been first effected by Michaelis.

Dieffenbach operated in 1830, Duval in 1837, Bouvier in 1838, and Guerin in 1839.

The chief varieties in the method of operating are those of Dieffenbach and Bouvier ; the former of whom divided the tendons from the deep to the superficial regions ; the latter in the inverse direction.

Method of Dieffenbach. The patient, supported by an aid, is placed upon his knees in a chair, while a second assistant confines the thigh of the affected side. The operator first divides the tendons of the semi-membranosus and semi-tendinosus in carrying the instrument beneath the skin and beneath the tendons. The biceps is divided in the same way. The extension is then increased to bring into view any fibres which may yet oppose the straightening of the limb, and these are successively divided. The punctures are carefully closed, and the other conditions of subcutaneous wounds as far as possible fulfilled.

Method of Duval. The patient lies upon his belly, and the leg is extended. The tenotome is introduced at the level and towards the anterior

face of the tendons, the most prominent of which is first to be divided. The leg is then farther extended, and other tendons become in their turn salient. The first is commonly the biceps, the second the semi-tendinosus, then the semi-membranosus.

For the former, the instrument should be introduced from the hollow of the ham outwards, and as far down as possible, to avoid the lesion of the vessels and nerves. Two punctures suffice; one for the biceps, the other for the two other muscles. The knife should not be allowed to perforate the opposite surface. It is made to bear directly upon the anterior part of the tendon, which is divided from its profound to its superficial and cutaneous surface. The pain is slight, a few drops of blood only escape, and the punctures heal in two days.

Method of Bouvier. Longitudinal punctures are made upon the eccentric border of the tendons to be divided. A blunt tenotome is introduced flatwise beneath the skin, while the finger of the left hand of the operator apprises him of the progress of the instrument. It is then turned upon the tendon, which is divided from without inward. The edge of the instrument should be so short as neither to enlarge with its base the external aperture, nor in dividing the biceps, to wound with its extremity the external popliteal nerve. From the puncture of the outer surface the biceps is divided; from the internal puncture, the semi-tendinosus, semi-membranosus, and if required, the rectus internus.

According to M. Bonnet, it is necessary in certain cases to divide not only the rectus internus and sartorius, but the gastrocnemii, which last is effected by severing the tendo Achillis.

From the dissections of this surgeon, it appears also that the nerves are sometimes so retracted as to resemble tendons. They may be distinguished, as was before stated, by their position in the centre of the lower part of the popliteal space, from the tendons, which pass to a point just inside the condyles of the femur.

The larger vessels are deeply seated; but the proximity of the popliteal nerve to the outer hamstring is sufficient reason for prefering the method of Dieffenbach, which protects it with the back of the instrument, to that of Bouvier which exposes it to the edge.

In certain cases, the section of the biceps alone suffices, especially in the variety complicated with inward deviation; but it not unfrequently happens that the semi-tendinosus and semi-membranosus become prominent a week or two afterwards and require division.

From the internal puncture may be successively divided the semi-membranosus which is deepest, then the semi-tendinosus, and finally the rectus internus. Resting here, we avoid the section of the internal saphæna nerve, but in dividing the sartorius, this nerve and vein are necessarily comprised in the section.

It is asserted by Little that it is better to divide

the superficial and cutaneous nervous filaments which traverse the surface of the gastrocnemii. They may be distinguished from fibrous filaments by the peculiar pain, sometimes severe, occasioned by their tension, especially during treatment.

Prof. Froriep of Berlin, reports a case in which the fascia lata, and fascia cruralis required division. Such cases are comparatively rare.

MECHANICAL TREATMENT IN THE CHRONIC FORM.

Two kinds of mechanical treatment have been applied to false anchylosis.

1. Immediate and violent.
2. Gradual and progressive.

Among the first are to be ranked the methods of Dieffenbach and Louvrier.

The second includes the methods of Duval, Bouvier and others.

SUDDEN EXTENSION.

The method of Dieffenbach differs from that of Louvrier. While the former divides the tendons and then violently flexes the limb, Louvrier directs the effort to its extension, and without section of the tendons. In the one case, the punctures of the integuments are liable to laceration; in the other the tendons are almost of necessity ruptured.

Method of Dieffenbach. Immediately after the division of the resisting tendons and fibres, and

also of any profound cicatrices which offer impediment to extension, the operator places one hand upon the thigh of the patient, and with the other seizes the foot and forcibly flexes the limb. It is then alternately flexed and extended, the principal effort bearing upon the flexion. To effect this the united force of two or three men is sometimes requisite.

The rupture of the adhesions is attended with cracking explosions. The punctures covered during the operation by the fingers of the operator, to exclude the air, are now closed with sticking plaster, the limb enveloped in a roller, and placed in a splint.

It sometimes happens that the limb constantly returns to a state of flexion after extension; a movement due to the retraction of the lateral ligaments. The external ligament is commonly the one affected, and is then perceptible beneath the skin, and requires division.

Method of Louvrier. The barbarous method of *M. Louvrier* needs only an allusion. The limb is confined in splints, hinged at the knee. The patient is placed in recumbent a position, and forcible extension is applied at two points, by means of cords wound around a roller. By one the foot is drawn down, while the other simultaneously depresses the knee towards a straight line. Extension is thus effected in twenty-five or thirty seconds; but not without rupture of the skin, and of the tendons of the ham, denudations of the vessels and nerves,

gangrene, and in one instance suppuration and death the twenty-second day. In another case, the artery was ruptured, gangrene ensued, and amputation was rendered necessary.

The method of Dieffenbach is not exempt from these accidents. Duval[1] reports a case of fever, local suppuration and delirium following the operation.

Such results peremptorily forbid the adoption of these methods in chronic cases, especially as equal advantage is to be derived from a gradual and much less painful application of force.

In recent cases, of not more than three or four months standing, and the result of acute inflammation, circumstances may render it expedient to break the adhesions by sudden force, but even then gradual extension is to be preferred in a majority of instances. In such a case, when the inflammation has subsided, manual force may be applied as described by Bonnet.

For this purpose, the flexors of the leg are relaxed by a horizontal position of the patient. An aid confines the pelvis, while another supports the foot. The surgeon now with one hand carries forward the head of the tibia, to prevent its backward luxation, while with the other he depresses the inferior extremity of the femur. The leg when reduced is placed in a hollow splint, and enveloped in a starched bandage.

Slowly progressive extension. In this method,

1 Op. cit., p. 455.

the two portions of the limb are confined in splints, hinged at the knee, and brought into a straight line by long continued traction or other mechanical means. The process is often completed in less than a month after the division of the tendons. In exceptional cases it requires three or four months.

In the construction of these machines, care should be taken to distribute and equalize the force. It has been elsewhere shown, that the tibia is disposed to backward luxation, and often requires to be urged forward at the moment extension is applied. Perhaps the best machine is that described by Little. The apparatus of Bonnet, which resembles the apparatus of Louvrier, and imitates the manner already described, of applying manual force, is also efficient.

The punctures are allowed to cicatrize, and the limb is well protected with cotton before being submitted to the machine. A flannel roller is then applied, somewhat tighter at the knee than above or below, to aid in counteracting the tendency to flexion. Extension at first progresses rapidly, even when the flexion is considerable, to the extent of thirty or forty degrees in a week; but is subsequently more gradual and laborious.

When the knee becomes painful and engorged, Duval advises local friction, with the ointment of Iodide of lead, already alluded to; and compression by means of a flannel roller. The machine is then re-applied. Pain is always an indication for the removal of the apparatus and examination

of the limb, as in the treatment of club-foot. When the sections are recent, a slight movement of the limb is apt to occasion great suffering. It should, therefore, be well supported while the apparatus is changed.

It is sometimes at the option of the patient, whether the limb shall be entirely reduced, or whether it shall remain flexed at a slight angle; the latter position being undoubtedly the most convenient, especially in ascending a hill, or going up stairs.

Different machines will be found described in the plates. (figs. 26, 28, 29, 30.)

RESTORATION OF MOBILITY.

At this stage, Little commences a new treatment for the purpose of restoring the mobility of the joint. The method consists of passive movements, frictions, vapor baths, &c.; with the occasional flexion and extension by means of a machine applied to the leg. This difficult process requires a period varying from three to six, and even twelve months.

MECHANICAL TREATMENT WITH TENOTOMY DURING INFLAMMATION.

Certain cases of anchylosis must be considered as a favorable termination of the disease. To interfere with the process, would renew the inflammation. Little considers tenotomy inapplicable, until

two or three years after the termination of active inflammatory symptoms; and cites a case in which disease was renewed, apparently from a neglect of this rule.

M. Duval maintains an opposite theory, and while he deprecates, in such cases, unaided mechanical treatment, he maintains, in a memoir addressed to the Academy of Sciences, in December, 1841, that "club-feet and false angular anchyloses of the knee, may be cured during the course of the inflammatory maladies which produced them."

The following passage more fully illustrates this point.[1] "When there is an inflammation of the knee, the seat of which is shown by the nature of the pain to be in the soft parts;[2] which is not diffused, but circumscribed; localized, so to speak, in the interior region of the articulation; when the flexion is due to the permanent retraction of the muscles; when, I say, there is this combination of circumstances, and the inflammation has resisted all common therapeutic means, I believe that everything is to be expected from the section of the retracted muscles, whatever be the local disorders of the articular parts. By this operation, we shall avoid also, the chance of anchylosis in a bad position.

"Supported by numerous facts, I believe I may announce the following doctrine. Pain, inflam-

[1] Duval, p. 438.

[2] It may be remarked that little indication of the seat of the lesion can be drawn from the character of the pain.

mation, alteration of intra and extra-capsular parts, or of the teguments, phlegmonous swelling, oedema, numerous cicatrices, suppurating surfaces; all these circumstances, which seem to be so many contra indications, ought not to arrest the operator; but are, on the contrary, indications to induce him to act. All prejudices which might have previously arrested him ought to yield to facts."

The tendons being divided, gradual extension is applied to the limb.

This principle is based upon a number of facts; and is supported upon the ground, that extension, while it brings in contact new and less diseased parts of the articulating surfaces, separates the posterior and ulcerated portions from each other, and by relaxing the muscles, diminishes the pressure of the patella upon the anterior surface of the femur. Extension applied before section of the retracted flexor muscles, would evidently counteract these indications in bringing the inflamed surfaces more forcibly in contact.

M. Guersent, of the Hôpital des Enfans, asserts[1] that in white swelling of the knee it is almost always advantageous to practise tenotomy, the moment circumstances are tolerably favorable for its performance; that is to say, when the tumor is not extremely painful; when the inflammatory symptoms begin to diminish in intensity.

M. Ribes, a French writer of some note, ex-

[1] Gazette des Hopitaux, Juillet, 4, 1844.

presses himself as follows:[2] "Medical art is rich in therapeutic remedies for the relief of white swelling of the knee-joint, but in almost all cases, from a simple cause, they have proved utterly inefficient. This cause is the permanent and forced contraction of the flexor muscles of the leg. *Eh bien!* Why should we not perform, at the proper time, the subcutaneous section of the tendons of the semi-membranosus, semi-tendinosus and biceps muscles which keep up this uneasy state of things? By this easy operation we may rationally hope not only to relieve the existing pain and distress, but also very materially to promote the formation of anchylosis, and consequently the cure of the disease. This simple and safe operation is already admitted and recognised by surgeons."

It is unnecessary to say that great caution is to be exercised in accepting evidence of this sort, and especially in experimenting upon a lesion sufficiently grave to hazard the life of the patient.

[2] Med. Chir. Rev. Oct. 1844, p. 469.

RICKETTY KNEES.

This variety of distortion, commonly known as *knock knees* and *bow legs*, accompanies in many cases a ricketty diathesis in young subjects. It results in part from the flexibility of the bones. In the former variety the joint also becomes distorted, either from the relaxation of the internal ligament or the arrest of developement, or shortening of the external lateral ligament. The tibia is then directed obliquely from above downwards and from within outwards, while the femur forms another side of a triangle of which the summit is the knee. The articulating surfaces of the knee joint become oblique in the line of a perpendicular let fall from the summit upon the base of this triangle, and the extremities of the bone are often enlarged.

Medical Treatment.—In infants, a tonic treatment often suffices to rectify completely the deviation, especially the outward curvature. The fol-

lowing formula will give an idea of the treatment of Guerin, in the case of a child of two or three years of age.

[1] 1. Three salt water baths a week with the addition of one pound of gelatine to each. 2. Friction and *massage*[2] morning and evening. 3. Every other morning, fasting, a table-spoonful of syrup of gentian alternating with cinchona. 4. For habitual drink, infusion of chicory (slight laxative and bitter) with one third Eau de Vichy and one third old Bourdeaux. 5. Light but substantial diet; fresh eggs, simple soup; cooked leguminous vegetables and fruit; but neither raw fruit nor milk. 6. Country air. 7. No walking for some months.

The above course of treatment was prescribed by M. Guerin for an infant of two and a half years of age, whose limbs, previously affected with the outward curvature, became straight at the expiration of a few months after its adoption. A simple change of air and diet often produces the same effect.

Surgical Treatment.—When the child has attained the age of six or eight years, the firmness of the external lateral ligament in the inward deviation, renders it expedient to divide it, rather than to attempt its extension. In certain aggravated

[1] Writer's MS. of Guerin's lectures.

[2] The term *massage* may be rendered in English by the word *Shampooing*. It consists of friction combined with pinching and kneading of the muscles, and with the gentle alternate forced extension and relaxation of their fibres.

cases, the tendon of the biceps is retracted, which is then to be divided.

M. Guerin does not hesitate to divide the external lateral ligament, thus opening the articulation. He asserts that no ill effect results from this operation, (which I have often seen performed by him,) provided the rules for subcutaneous perforations of the articulations are strictly adhered to.

1. The section should be made in the position of extension. M. Guerin has endeavored to show that, in certain positions of the joints, a sort of vacuum is established in the articular capsules; which aids the effusion of the synovial fluid from the secreting surface, by a sort of action of suction. If this be established it becomes a matter of importance not to divide the capsule, when the joint is in such a position as to tend to draw into its cavity atmospheric and other surrounding fluids.

2. The air should be carefully excluded.

3. Perfect subsequent rest of the limb should be enjoined.

With the subsequent and long continued use of an apparatus, as M. Guerin affirms, the internal portions of the oblique articulating surfaces become absorbed, the leg occupies a perpendicular, and the deformity is permanently relieved.

Protracted mechanical treatment is required, to produce the requisite modification in the joint. Bonnet states, that he has never been able to obtain from this method a satisfactory result.[1]

[1] Op. cit., p. 575.

PERMANENT FLEXION OF THE HIP-JOINT.

The principles of treatment of false anchylosis of the knee, by gradual extension, apply equally to permanent flexion of the hip. It is, however, more difficult to appreciate in this lesion the amount of change in the articular structures. The distortion is corrected by mechanical force, either alone or combined with the section of tendons.

A year or two after the cessation of active inflammatory symptoms, gradual reduction may be attempted, by the traction of a weight, spring, or other mechanical power. If the tendons resist the effort, the tenotome should be employed.

The tendons which have been divided for this affection, are those of the adductor longus and magnus, rectus femoris, sartorius, pectineus, and, lastly, the tendon of the psoas and iliacus. The two last muscles have been divided by M. Guerin and by Dr. Sargent of Worcester. In the operation of the

latter surgeon upon a boy of ten years of age, in whom the deformity, of three years standing, was the sequence of apparent cerebral affection, the tenotome was introduced, about three inches below the anterior superior spinous process of the ilium, and carried in a direction parallel to Poupart's ligament, up to the edge of the femoral artery. The tendon being extended, the knife was carried to the bone, when the tension yielded.

Profuse hemorrhage followed the withdrawal of the knife, only arrested by compression sufficient to produce an eschar two inches in length. But the patient, who before the operation was a cripple, confined to his bed or walking upon his hands and knees, recovered, in a great measure, the use of his limb, and now walks erect without a cane.

It should be mentioned, that the puncture was first made, at a point about one inch and a half below the spinous process of the ilium ; and above the position of the profunda and recurrent arteries, which would have then escaped division. It proved however, that the cicatrices of previous sections, had condensed the tissues to a degree which rendered them impervious to the tenotome, which was then introduced still lower down. The crural nerve was divided. The proximity of the tendon of the psoas to the large vessels, will hinder less dexterous surgeons from attempting its division, notwithstanding the eminently satisfactory results of this case.[1]

[1] N. E. Quarterly Jour. of Med. and Surg. July, 1842.

ANCHYLOSIS.

Little need be said upon this point. It is rare that a case of simple deformity justifies the surgeon in hazarding the life of the patient to a degree, which the operation proposed for anchylosis demands. The integuments and soft parts are widely incised, and the bone, after being exposed, is sawed apart. The patient is left in the conditions of a severe compound fracture.

Dr. J. Rhea Barton first performed this operation upon the hip in 1827.[1] The neck of the femur was divided, and a serviceable joint was reëstablished; which, however, became again anchylosed at the end of six years.

A similar operation was performed by Dr. Barton, upon a knee anchylosed at an angle, in May, 1835.[2] The integuments were divided, and a wedge-shaped

[1] North Am. Med. and Surg. Jour., April, 1827.
[2] Am. Jour. Med. Sciences, Feb. 1838.

mass of bone was removed from the femur just above the condyles, the base of which, corresponded with the anterior surface of the bone. The limb was gradually straightened, the bone united, and the patient was enabled to walk without a cane.

The first of these operations was to establish a joint, the second to correct the deformity of the limb.

The latter operation was repeated with success by Professor Gibson in 1841,[1] and the former by Dr. Rodgers[2] in 1843, with like result.

Dieffenbach proposes, in his last work, to break down the osseous union of the knee-joint with an instrument, and Malgaigne suggests the employment of a chisel and mallet for the same purpose.

[1] Am. Jour. Med. Sciences, July, 1842.
[2] Ibid., Feb. 1843.

LATERAL CURVATURE OF THE SPINE.

The treatment of lateral, spinal curvature, has received much attention in France, and has recently been discussed at length, and not without warmth, in the Academy of Medicine. The principal advocates of the opposite modes of treatment, are MM. Guerin and Bouvier[1]; the one insisting upon the

[1] The following are the conclusions of M. Bouvier:

1. That the section of the sacro-lumbalis, longissimus dorsi, spino-transverse muscles, &c., is not immediately followed by diminution of spinal curvature.

2. The changes which the curves undergo during the succeeding mechanical treatment, are exactly identical with the changes produced by this treatment alone, when it has not been preceded by the section of the muscles.

3. The time necessary to obtain these changes is the same, whether we have recourse to orthopedic means alone, or practice also section of the muscles.

4. In a word, dorso-lumbar tenotomy has no kind of influence in remedying lateral deviation of the spine, properly so called.

M. Bouvier further concludes: 1. That the majority of lateral cur-

necessity of muscular section in certain cases of this distortion; the other maintaining, that no advantage is to be derived from it.

The question relates to the duration and efficiency of the mechanical treatment, alone, or accompanied with section of the muscles, and can only be satisfactorily determined by the analysis and comparison of a considerable number of cases, subjected to each method. The operation being attended with little pain, or chance of subsequent accident, is hardly to be taken into the estimate, if any advantage is to accrue from it. I believe M. Guerin has shown, as far as he is able, that the treatment is abbreviated in certain cases, by the division of the muscles. If it is established, that these tissues are liable to undergo the fibrous change in the region of the spine as well as the extremities, as it undoubtedly is, they must offer a certain amount of resistance to any attempt to extend them. That this resistance is not insurmountable, that the spinal column can be extended in spite of its influence, will be readily conceded by those who have seen the tense and undivided muscles of the ham slowly yielding to the gradual application of mechanical force; but this treatment is often accelerated by the section of the tendons

vatures of the spine are not owing to muscular contraction. 2. That the etiology of the distortion, pathological anatomy, and clinical experiments proscribe the section of muscles of the back in the treatment of these curvatures.

in the popliteal regions, and many are ready to admit, that the same advantage is to be obtained by the division of the tense dorsal muscles upon the concave side of an exaggerated spinal curvature.

The two modes of treatment need farther investigation; but in rejecting the exclusive views of the partisans of either method, the evidence renders it highly probable, that the treatment of lateral curvature is often accelerated by dorsal myotomy.[1]

[1] This subject has been revived in the Academie de Medicine by M. Malgaigne. After a tedious and excited discussion upon the value of dorsal myotomy, the matter was referred to a committee, of which Roux and Velpeau were members. The report of this committee was read to the Academy, 12th November, 1844; and may be considered as embodying all that is yet settled upon this point. The following are extracts from this report:

"Although it should be proved that tenotomy was unavailing in the cases cited by M. Malgaigne, we should have no right to deny, for that reason, that the operation was ever efficacious."

* * * "We do not admit, that spinal curvatures are unaccompanied with muscular contraction in all subjects."

* * * "But it is important not to deceive ourselves upon the value of tenotomy in such cases, and not to decide upon it unless we can establish *materially* the existence of unyielding or tense cords upon the concave side of the deviation; not during the influence of certain active positions, but when we try to straighten the curve by foreign force."

And among the conclusions,

"6. Nothing at present justifies the opinion of those who attribute the majority of lateral curvatures of the spine to convulsive or active retraction of the muscular system.

"7. But, the secondary shortening of certain muscles in the concavity of the curves, ought to hinder us from rejecting, *a priori*, and absolutely, spinal myotomy."

The question thus stands much as it did before.

The pathology of the lesion has been thoroughly reviewed by M. Guerin, whose opportunities have enabled him also to investigate many practical considerations connected with the treatment.

The following is a brief exposition of the views of M. Guerin, with such additions as embrace the more important suggestions of other writers.

CAUSES.

A lateral deviation of the spine presents certain alterations in the conformation, structure and relative position of the vertebral column and surrounding tissues. The advanced age of the patient, the long duration, or the exaggerated degree of this distortion, are conditions which give rise to secondary alterations, and place such deviations beyond the reach of art.

Tuberculous and other disease of the bones, anchylosis and osseous transformation of the fibrous structures, are also cases foreign to the class about to be described.

Certain forms are eminently adapted to receive aid from an operation; greater in proportion to the youth of the patient and the inconsiderable degree of distortion. In such cases, the muscles, which form the chord of the principal curvature, are either primitively or consecutively contracted; and display themselves in certain positions of the body in the form of a resisting fasciculus, which hinders the vertebral column from assuming a normal posi-

tion. This muscular retraction is identical with that of club-foot and wry-neck.

As a primitive lesion, and a cause of osseous distortion, lateral deviation is *congenital* or *non-congenital.*

CAUSE OF THE CONGENITAL VARIETY.

That the *congenital* variety is due, like other congenital deformity, to muscular spasm, resulting from nervous influence, is shown

1. By the frequency with which deviations of the spine and other articular deformities, such as exaggerated distortion of the superior and inferior limbs at their different joints, and also of the hands, feet, &c. coexist in fœtal monstrosities, which offer evident alteration of the brain and spinal marrow. These cases present marked muscular traction in the direction of each deformity, proportioned in degree to the intensity of the lesions of the nervous centres.

2. By congenital deviations of the vertebral column observed in the living subject, and accompanied either with strabismus, club-foot, torticollis, or other distortion of the skeleton, or with appearances of convulsions in the face, irregularity of the two halves of the cranium, or diminution of force and even paralysis in certain parts of the muscular system; or, finally, with veritable congenital spasmodic affections, such as epilepsy, hemiplegia, paraplegia, with or without muscular contraction.

In the non-congenital form, it is equally shown by cases of spinal deviation, dating from a period subsequent to birth and immediately following cerebral or cerebro-spinal affections.

It is accompanied as in the two preceding forms, with a great number of other deformities, such as strabismus, torticollis, club-foot, deviations of the knee, all dating from muscular convulsions, and accompanied with retraction of the muscles exactly in relation with the form and degree of the deformities.

In these three varieties, the essential characters of the disease are the same, and identical with those in which the deviation alone remains to indicate the existence of a similar cause at some previous period.

MUSCULAR RETRACTION.

Muscles. The anatomical characters of the retracted tissues accompanying spinal deviation are the same as those of retracted muscles in other regions.

At first, in a state of spasmodic contraction, they become in a measure paralyzed, their developement is arrested, and degeneration commences; fibrous if they are submitted to traction; fatty in a state of repose.

The condition of active contraction differs from that of passive retraction. In the former, the muscle is tense, acts as the immediate cause of the ver-

tebral curve and limits its extent. In the latter condition, it merely accommodates itself to the distance between the extremities of the curve, and is less forcibly extended.

In both cases the shortened tissue is moderately resisting. In the former or fibrous change, the tissues are felt beneath the skin, a hard, fasciculated mass, occasionally giving the sensation of fibro-cartilage, if the column be extended. The muscle is found to be diminished in size, retracted, paler, of a whitish yellow, of an eminently fibrous or fibro-fatty texture, contrasting strongly with the regular form, red color, and fleshy consistence of the corresponding normal muscles. The *longissimus dorsi* is occasionally so fibrous that its aponeurotic and tendinous portion acquires a double length at the expense of the muscular portion.

In the *fatty degeneration*, the muscle becomes somewhat softer than natural, and retains its original volume.

After the section of muscles thus retracted, the extremities reunite by means of an intervening portion, of adequate length; this tissue regains its normal character, and becomes, in a word, muscle.

Vertebræ. Upon the convexity of the curvature, both the vertebræ and their intervening fibro-cartilages increase in thickness, while the concavity is marked by a corresponding absorption and diminution of substance of the same parts. They thus acquire, individually, a wedge shape.

Ligaments. In cases of long standing or of

great deviation, the ligaments may become retracted and even ossified, in consequence of which the vertebræ tend to become anchylosed.

Thorax. The ribs follow the deviation of the spine, and in exaggerated examples the thoracic cavity is distorted and compressed, and the contained viscera are modified in position, form and structure. Portions of the lungs may become indurated, and even acquire a fibro-cellular structure.[1]

The progress of this sort of deviation is chiefly due to mechanical causes. The column once bent is powerfully acted upon by the weight of the body in a vertical position, to a degree which slackens the extended cords, and renders it difficult to detect them beneath the skin. They are not for this reason less efficient in retaining the spine in its anormal position; and an upright posture commonly restores their tenseness and indicates their locality. In a young and recent subject this tenseness may be made apparent by suspending the body by the head.

The amount of retraction is sometimes considerable, amounting to a third of the length of the muscle, and is always proportioned to the curvature. In some cases the muscles, situated on the convex side of a curvature, slip over the spinous processes to occupy a position upon its concavity.

[1] Diff. du Syst. Oss., p. 26.

CAUSES OF NON-CONGENITAL VARIETY.

Among the causes of the non-congenital form of spinal deviation, are

1. The convulsions of infancy. 2. Local or general spasmodic action occurring at a later period of life.

These causes, recognised as producing distortion of the limbs and neck, have also their influence upon the muscles of the vertebral column, which is thus suddenly curved, though the resistance of its surrounding tissues may render the deviation so inconsiderable, as to prevent its immediate detection. Wounds of the muscles of the back, and blows or other violence to these tissues, may be an immediate cause of their permanent contraction.

Other causes are, a want of general muscular and ligamentous force; an inequality in the antagonizing power of opposing muscles; the paralysis of some of them; an abnormal inclination of the plane of support; a primitive inequality of the two halves of the skeleton; ricketty or scrofulous tendencies; any of which suffice either to create a deviation, or to occasion a pre-disposition to curvature, which the agency of slight causes developes. The superincumbent weight of the body, and the tendency of the muscles to accommodate their length to the distance between the approaching extremities of the arc, augment the curve in pro-

portion to their force, and the inability of the parts to resist their influence.

CURVATURE AND TORSION.

A lateral deviation of the spine consists of two elements, to be separately considered. 1. *Curvature.* 2. *Torsion.*

Curvature is of two kinds. The one occupies the immediate seat of the lesion; the other is an accompanying and compensating deviation. The trunk always tends to maintain an upright position. As soon as a part of the vertebral column deviates from a perpendicular, another portion institutes a curve in an opposite direction, by way of restoring to the mass its centre of gravity. For this reason, a single curve never exists alone. It is rare that two are found unaccompanied by a third. Three are very common, and four occasionally met with.

The position of the spinous processes is not in all cases an indication of the extent or direction of the deviation. In a pathological specimen exhibited to the Academy of Medicine, the column viewed from behind, offered a single curve, while the bodies of the vertebræ in front, presented four. This apparent anomaly is due to *torsion*, which accompanies all cases of deviation.

The principle of torsion is illustrated by an attempt to bend a blade of grass, or a flat, flexible stick, in the direction of its width. The centre immediately rotates upon its longitudinal axis to

bend flatwise in the direction of its thickness. In the same way the spine, laterally flexed, turns upon its vertical axis to yield in its shortest or antero-posterior diameter.

The centre of rotation or torsion is a vertical line through the summits of the spinous processes, which remain, in consequence, comparatively stationary, while the bodies of the vertebræ rotating around this centre, tend to occupy the outside of the convexity. For this reason it often happens that the principal curve alone can be detected by the direction of its spinous processes, and writers have been thus led to admit the existence of single curvature.

Each vertebra of a curve is laterally bent upon its antero-posterior axis; and the spinous processes are thus inclined towards the transverse, upon the convexity of the deviation. The vertebræ of transition from one curve to another are alone to be excepted from this rule.

Other elements of the mechanism of torsion, are,

1. The disposition of the articulating surfaces; which, in the cervical and dorsal regions, are oblique, while in the lumbar region they are nearly transverse.

2. The resistance of the lateral muscles, which become subsequently retracted. Among the principal, are the costal insertions of the longissimus dorsi, the inter-spinales, and the inter-transversales muscles and ligaments, which confine the summits

of the processes, while the bodies of the vertebræ yield to the effort of flexion.

GIBBOSITY.

To the action of torsion is due the prominence of the ribs, muscles, scapula and shoulder upon the convex side of the curve and the corresponding depression upon the concavity. This deformity, commonly termed *gibbosity*, is constant in cases of pathological deviation.

CURVES—THEIR POSITION AND MECHANISM.

It is rare to find two vertebral columns, pathologically distorted, which offer precisely the same characters. Nevertheless certain curves are more frequent than others. A convexity to the right, above, and to the left, below, is more common than the reverse.

The principal curve, commonly occupies the dorsal, or dorso-lumbar region; a circumstance explained by the fact, that the centre of the *movements of totality*, of the vertebral column, and of lateral flexion in particular, is situated at the point of junction of the dorsal and lumbar regions. It is due to the following anatomical disposition of the articulation, uniting the eleventh and twelfth dorsal vertebræ.

1. "The articulating facettes are more perpendicular and transverse.

2. "A sort of notch is formed by a prolongation

upwards and forwards of the superior tubercle of the transverse process of the twelfth dorsal vertebra, which is recurved like a hook, so as to convert into a transverse groove, the space comprised between this appendix and the superior articulating process of the same vertebra. In this groove is received the inferior edge of the articulating facette of the eleventh dorsal vertebræ, which slides there without the least of obstacle during the movements of lateral flexion of the column. Besides this circumstance, certain muscles, the quadrati-lumborum, the common mass of the sacro-lumbalis, longissimus dorsi and semi-spinales, which are the agents of lateral flexion, are, to a certain extent, circumscribed in this region, and belong especially to it."

A similar conformation, but less marked, exists in the neighboring dorsal vertebræ, which gradually lose this peculiarity in receding from this point; so that the natural curve, in the lateral movements of the spine, decreases from the loins upward.

A single principal deviation once established, *curves of compensation* immediately follow, as the result of subsequent active muscular contraction, and the trunk is restored to a perpendicular.

These secondary curves are sometimes hardly appreciable. That occupying the cervical region is often slight, and when masked by the action of torsion, is sometimes not indicated by a corresponding curve of the spinous processes. As was before remarked, an evident alternate deviation of the bodies of the vertebræ of the entire column, some-

times presents no appreciable variation from a perpendicular, when viewed from behind.

A dorso-lumbar deviation is always arrested in the dorsal region to give place to a curve of compensation. Though more frequent at the junction of the lumbar and dorsal vertebræ, the distortion may occupy any portion of the vertebral column, and is attended with a general prominence of the parts upon its convexity, and a corresponding depression in its concavity.

Exaggerated deviation is accompanied by *wrinkles of the skin*, corresponding to the concave side of the most considerable curve; often a short distance below the axilla.

The trunk, supported by alternate curves, is very slightly, or not at all, inclined; the hip, never elevated, if the legs be of equal length; and the subject does not necessarily walk lame.

The *muscles*, which are commonly retracted in the principal or dorso-lumbar curvature, are the common mass of the sacro-lumbalis and longissimus dorsi; in the central dorsal region, the same mass, with the spinalis and semi-spinalis dorsi; at the cervico-dorsal curve, the complexus, cervicalis ascendens and transversalis colli.

The lesion may occupy other positions. Certain portions of the trapezius may be retracted and fibrous, by the side of other portions, paralyzed, atrophied and membranous, and by the side of other healthy muscle. All the muscles of the back are sometimes retracted, producing great distor-

tion. The long dorsal may be alone retracted, by the side of the sacro-lumbalis, passively affected; or a simple fasciculus of one of these muscles, may offer a state of tension in the midst of healthy tissues. In such cases it is amply proved, that the extended muscular bands, when subjected to torsion, may become retracted; in other words, their developement is arrested; they are, in a measure, paralyzed, and more or less transformed into fibrous tissue. In such conditions they fulfil, with regard to the spine, the functions of a string in a bent bow.

TREATMENT.

Distortion of the spine is less amenable to treatment than other deformity; chiefly, perhaps, from the difficulty of applying to it a permanent and properly directed mechanical force. A first difficulty presents itself in the necessity of flexing the entire body, in order to affect corresponding flexion of the vertebræ. The mass is unwieldy, and a lateral effort can be applied only through the intervention of the ribs, shoulders, or pelvis. Nor can this power be maintained for a length of time. The respiration is impeded, the posture is constrained, the integuments are irritable, and the trunk impatient of confinement. The mechanical treatment must be frequently suspended, and in these intervals, various influences, among which the vertical weight of the trunk is not the least, tend to

reproduce the deformity. The subsequent exercise of the muscles, so important in orthopedic treatment, can only be accomplished in the region of the spine, by exaggerated and comparatively fatiguing movements of the whole trunk.

It is obvious, that such conditions are far less promising than those which commonly attend the treatment of club-foot; where the whole distortion is embraced by the apparatus, which maintains an unremitting and progressive force, as long as it may be required, and where the gentle exercise of walking subsequently secures the advantage obtained from the use of a machine.

The results of the treatment of spinal curvatures are, as might be expected, much less satisfactory than those of most other distortions, while the time required is longer; and hence the difficulty of deciding between the claims of different methods.

The deformity is often inconsiderable and stationary, and requires no treatment.

At other times the constitution of the patient is to be fortified with change of air, and food, with salt baths, cold douche, frictions and *massage*. Exercise in the open air is important, and the mechanical treatment of this deformity is always combined with gymnastic exercises. These should be so contrived as to strengthen the muscles upon the convexity of the principal curve, and to elongate those upon its concavity. Such are, climbing the under-side of a spiral ladder; turning a crank above the head and on

the side of the concavity, in the horizontal position; a lateral rocking horse inclined towards the side of the concavity; which will serve as examples of a great variety of contrivances, obvious to a machinist.

A bag of sand or shot, carried upon the head, while the patient walks, is an excellent method of exercising the dorsal muscles.[1] But when the patient is at rest, its vertical weight would obviously tend to exaggerate the curvatures.

If, however, in certain postures of the patient, a tense fasciculus appears beneath the skin, upon the concave side of the principal curvature in the position of a chord, uniting the two extremities of the arc, there is little doubt that the progress of mechanical treatment will be accelerated by its subcutaneous division. Were the section of muscles unnecessary, the operation is attended with no danger and with little pain or hemorrhage. It offers no impediment to subsequent mechanical treatment, which is the same in every respect except in its duration, whether the muscles be severed or not.

SURGICAL TREATMENT.

In such a case, the exact position of the retracted fasciculus is ascertained by placing the patient in a vertical or horizontal position; or by

[1] The straight backs of negroes, and people accustomed to carry weights upon their head, are proverbial.

making extension, if requisite. Parallel extension is sometimes used to effect an elongation of the muscles preparatory to their section.

OPERATION.

M. Guerin nowhere indicates the manual of the operation. In those I have seen performed by him, amounting to a dozen or more, the patient was laid upon his belly upon the table. The hands being extended by the side, the patient was desired to raise his head; an action by which the dorsal muscles were brought into play and their retracted fibres made tense. A fold of skin was then pinched up at the outer edge of the extended fasciculus, and, a puncture being made, the myotome was introduced flatwise at its base, at a point which afterward receded to the distance of an inch from the external border of the muscle. The knife being then turned upon the mass, the fibres were divided by a sawing motion communicated to the convex edge of the blade.

By reason of its fibrous character, the resisting cord is divided with precision and at once; and its complete section is attended with a sharp and distinct explosion, as the extremities recede one from another. On the other hand, non-retracted muscular fibres are soft, and yield to the instrument, which is unable to effect either a clear or a rapid division of their substance.

Immediately after the operation, certain elements

of the deformity disappear at once; and what is important, other fibres rise to take the place of those which have been severed. They often occupy nearly the same position, and their section is attended with an additional correction of the deviation.

The same phenomenon sometimes appears at the end of six or eight months after the commencement of mechanical treatment. When in such a case the curvature remains undiminished during several months, the re-division of the muscles is attended with a new diminution of the curve, generally rapid during the first days after the operation.

MECHANICAL TREATMENT.

Mechanical treatment is effected either by *portable apparatus*, which allows the patient to move about, or by *mechanical beds*, in which force is applied horizontally.

In the former, a broad metallic belt embraces the hips, and serves as a fixed point, from which extension is applied either to the head or more commonly to the shoulders. The inconvenience of the latter method is apparent. The shoulders and scapula yield to the force, while the vertebral column is unaffected by it.

The apparatus of Hossard, modified by Tavernier, does not aim at extension. It consists of a belt of wadded leather, four or five inches broad, and fixed around the pelvis by horizontal and perineal straps.

Behind, a steel upright reaches to the height of the shoulders, and is attached to the belt by ratchet work, which admits of its lateral inclination towards the shoulder of the concave side of the curve. From its summit a broad strap winds spirally downward round the convexity of the curve, which it presses towards a perpendicular, and is fixed to the belt in front. The trunk being thus thrust from its centre of gravity, tends, in recovering itself, to correct the spinal deviation.

The strap should traverse the most salient point of the ribs behind, while a second strap passes, if required, in the contrary direction around the lumbar curve. This efficient apparatus does not forbid active exercise. Its great advantage is, that the correcting force is purely muscular; and derived from the efforts of the body to regain the perpendicular from which it is thrust by the machine.

On the contrary, *the shoulder supports*, and the *Minerva* already described,[1] which exercises traction upon the head, are substitutes for muscular action, which they enfeeble, in supplying its place.

[2] Marshall Hall proposes to take a plaster cast of the body, in an upright position, and to deposit upon it, by the galvanoplastic method, a coating of copper. The whole is sawed in two, vertically, and a pair of copper corsets are thus produced exactly fitted to the trunk. The idea is ingenious,

[1] See page 124 and plate, fig. 24.

[2] Lancet, Feb. 3, 1844.

but the principle of support is open to the objection just mentioned.

Various *orthopedic beds* have been devised for the purpose of effecting horizontal extension. In these the force is best applied in one of two ways. 1. In a direction parallel to that of the spine. 2. In a direction perpendicular to it.

PARALLEL EXTENSION.

Parallel extension is effected by fixing the pelvis and applying an extending power to a series of straps passed round the chin and head. This is best effected by the machine about to be described for the second method.

This method is applicable in old and very pronounced curvatures, where the extent of the curve gives power or *purchase* to this simple traction. Also in the deviations with four curves, or where two closely follow each other in the dorsal region. It is then impossible to apply perpendicular force to each curve separately, on account of their proximity. Continued force of this sort is liable to produce a relaxation of the ligaments, which predisposes the spine to a recurrence of the deformity. It also tends to efface the natural antero-posterior curves. Many young people treated in establishments where these beds are exclusively employed, have their backs flattened; the shoulders and other regions of the vertebral column being reduced to the same plane. These ill effects are to be com-

bated by suitable gymnastic exercises alternating with extension. Horizontal extension also acts but indirectly upon the wedge-shaped conformation of the vertebræ, its power diminishing as the curve becomes less marked.

SIGMOID EXTENSION.

The method which Guerin has called *sigmoid extension* consists of several elements.

The first of these is parallel extension, the head and pelvis being respectively attached to the top and bottom of the bed.

The second is a lateral force applied to a point upon the side of the trunk corresponding to the convexity of the curve, and in a direction perpendicular to it. The action is analogous to that of straightening a bow, when the extremities are held in the hands, and the knee is applied at an intermediate point of the convexity. It has several advantages over parallel extension. The power is applied to greater advantage ; and a temporary curve in the opposite direction is substituted for the original curve ; as in the attempt to straighten a bow.

This feature of sigmoid extension is of great importance. To effect it, two uprights are placed upon opposite sides of the bed, one above the other, at points which correspond with the convexity of each curve ; and are capable of being advanced towards a median line and fixed in that position.

This simultaneous application of the power to the extremities and convexity of the double curve or S, suggested the term *sigmoid* extension. It is the more efficient, as many deviations have their principal curve at the level of the dorso-lumbar region, which answers to the articulation already described of the eleventh and twelfth dorsal vertebræ ; a disposition which greatly aids the action of the machine.

A third peculiarity is the combination of flexion and extension. It is effected by placing the centres of rotation of the upper and lower portions of the bed upon opposite sides. In illustration of this, provide a strip of board, and a pair of compasses, the length of which is equal to the width of the board. Saw the board across, and placing the shut compasses horizontally in the interval of division, attach a leg to each of the sawed surfaces. The joint of the compasses forms a lateral centre of rotation for the boards; and in flexing one board upon the other, the triangular interval of separation gradually increases. If the board be again sawed and provided with a similar joint upon the opposite side, this arrangement will represent the orthopedic bed, employed by M. Guerin, in which a joint corresponds to each of the two principal curves. The body of the patient fixed upon it is at once flexed by the joints, and extended by the increasing intervals of separation.

A helmet is united to the apparatus by a universal joint, and serves for the mechanical treatment of torticollis. It is capable of being fixed in

any position which the cervical vertebræ in their normal state, are capable of assuming, and serves as a point of counter-extension to the pelvis, which is attached by a belt and straps to the foot of the bed. It should be remarked, that the extension of the head is in reality effected, not by the helmet, but by a stuffed collar of iron suspended from its lower margin.

M. Guerin finds it inexpedient to flex simultaneously, the upper and lower tables of the bed; and when there are two principal curvatures of nearly the same degree, they are treated alternately in different parts of the day.

When there is a single principal curve for which the muscles have been divided, M. Guerin directs attention to this, to the exclusion of the less marked curves of compensation. In such a case, the body being extended, is thrust to the side of its concavity by the aid of the uprights alone; one of which is applied to the convex point, while the opposite supports the pelvis. The tables of the bed are then not flexed.

In certain scrofulous and other deviations without muscular contraction, simple flexion may be required, without extension. It is effected by a bed like that described; but possessing but one division, with its axis of lateral flexion at a point equi-distant from the two sides.

The apparatus will be better understood by referring to the annexed drawings. (figs. 31, 32, 33, 34.)

CONTRACTION OF THE HAND AND FINGERS.

The section of tendons in the hand is much less uniformly productive of good results than in many other regions, and its propriety has been disputed. The indications for the operation are not yet clearly pointed out. It has been performed by most orthopedic surgeons, but it is doubtful if it is ever efficacious, while it is certain that the fingers are sometimes disabled by the operation.

CAUSES.

The distortion is sometimes due to diseases of the bone. That form which is the effect of contraction of the tendons, or which is accompanied by this symptom, recognises a variety of exciting causes. It is occasionally, but rarely, congenital. It results from cutaneous eruptions, fractures, wounds or abscesses. It also follows

paralysis of antagonizing muscles. In the variety thus accompanied by active or passive muscular retraction, which alone offers conditions for tendinous section, the tendons are resisting and in high relief beneath the skin.

The deviation is rarely due to a single set of muscles, and it commonly presents a combination of the various movements of the hand. Flexion of the hand is sometimes accompanied with extension of the fingers or with a lateral inclination, and with flexion of the phalanges. The muscles of the arm not unfrequently participate in the affection, and the fore arm is more or less flexed or pronated.

It has been demonstrated by Froriep of Berlin, that the palmar aponeurosis, when retracted, may aid in the flexion of the phalanges, by means of fibres which it supplies to each side of the fingers. In certain cases the joints are partially anchylosed, and require forcible extension.

The section of the flexor tendons of the fingers is frequently, if not in all cases, followed by a loss of power in the hand. The phalanges can no longer be flexed. It has therefore been a question whether their division should ever be attempted. In support of the affirmative, it is urged that the deformity is in a great measure relieved; and that in unsuccessful cases the hand yet retains sufficient power to grasp large objects. But it is probable, that were the chances fairly represented, few patients would consider the shape of a hand an inducement to hazard the loss of its use; and the

histories of cases like that of M. Doubouvitski,[1] will deter most surgeons from attempting the division of the tendons in this region.

OPERATION.

For the deviation of the entire hand, which is rare, it suffices to divide the palmaris longus and brevis, and perhaps the flexor carpi ulnaris if there be a lateral inclination of the hand. These tendons are subcutaneous, and easily divided. The motions are generally restored, when the contraction is not due to paralytic affection of the antagonizing muscles.[2] More commonly, the flexors of the

1 In this well known case, many tendons of the forearm and hand were divided by M. Guerin; among them, the deep flexor in the fingers and the superficial flexor tendons in the forearm. The patient, who was before able to retain an object in the contracted fingers, lost all power of flexing the phalanges, and the hand became in consequence, comparatively useless.

Similar instances are not wanting. The case of Jenny Wilson reported by M. Guerin to the Acad. des Sciences, to illustrate the innocuity of the division of thirteen tendons, was examined by M. Phillips, a year afterwards at the Salpetriere. He sums up the anatomical details as follows: "This patient remained during nine months in the service of M. Guerin at the 'Hopital des Enfants.' She bitterly deplores, as well as her mother, the results of all the operations she has undergone. Before these sections she could make a movement with the fingers which permitted her to hold a needle, which she then seized with the mouth to be again taken by the fingers. By these movements she could sew fast enough to make shirts. Now, this sole resource no longer remains; she is condemned to vegetate in a service of incurables at the 'hospice de la Salpetriere.' The thirteen sections were made in the forearm, in the two legs, and two feet."—*Annales de Chirurgie*. Paris, 1841; t. ii. p. 130.

2 Little in Lancet. Dec. 16, 1843.

fingers are also retracted and the phalanges drawn toward the palm. The first phalanx often remains straight, while the two last are flexed upon it.

After dividing the flexors in the forearm, the hand may be more or less extended, but when, as it often happens, the fingers are stiff and unyielding, the surgeon is called upon to decide upon the expediency of additional sections in the palm and fingers. In such a case, extension may be sometimes effected by force, but it should be previously ascertained that the resistance is not due to the retraction of tendons or palmar aponeurosis.

As was before stated, the division of the tendons of the palm and fingers is rarely successful. The section of the deep flexors at the level of the second phalanges allows the extension of the fingers but paralyzes their power of flexion. The tendon is drawn back through the bifurcation of the superficial flexor, and an interval is thus formed between the divided surfaces, which are hindered from uniting by the presence of the synovial fluid.

In the present state of knowledge upon this subject, it may be affirmed that the superficial flexors of the fingers should never be divided at the base of the first phalanx, but rather in the forearm. The proximity of the median nerve at the wrist, compels us to divide the *deep-seated flexors* in the palm, if at all; but the reunion of their tendons is uncertain. The operation is indicated only when a single finger is permanently flexed, and interferes with the movements of the rest.

The flexors of the toes are sometimes retracted, and may be divided in the sole, the reëstablishment of motion being here of comparatively little importance.

Little benefit is obtained in most cases from a simple division of the cicatrices consequent upon burns, especially upon the palmar surface.

MECHANICAL TREATMENT.

Immediately after the section, the patient is apt to experience severe and deep-seated dragging pain in the arms, due to the forcible contraction of the muscles. The pain is alleviated by frictions and steaming.

The hand being well protected, is confined in contact with a straight splint, extending from the elbow to the extremities of the fingers. The splint may be provided at the wrist with a hinge regulated by a screw or other mechanism, so contrived as to fix it at any required angle. The whole may be supported in a sling.

CONGENITAL DISLOCATIONS.

Numerous well described cases of the different varieties of congenital luxation are to be found in the papers of various writers, especially since the subject has received general attention. Although interesting, in an anatomical and pathological point of view, they are generally to be referred to the principles laid down by Guerin in his memoir upon this subject, which is the groundwork of the following chapter.

CAUSES.

Certain forms of congenital dislocation are due to the paralysis of certain muscles.

Luxation resulting from disease of the bone is unaccompanied with active muscular retraction, and easily distinguished.

The affection is due in a large majority of

cases to muscular retraction ; and resembles in this respect club-foot and wry-neck. It accompanies these distortions, and is found in acephalous and other anormal conformation of the nervous system.

LOCALITY AND PROGRESS.

Any joint in the body is liable to dislocation from muscular retraction.

The luxation may be *partial* or *complete*. At an early period of fœtal life, the articulating cavities are imperfectly formed, and the articular extremities easily extend the yielding ligaments, and escape from their normal positions. At a later period, when the sockets are more completely developed, the dislocation is commonly partial.

The progress of the luxation is due to the arrest of the developement of certain muscles ; to the physiological contraction of others ; and to the superincumbent weight of the body. These forces in the end complete a dislocation which was at birth partial. In such cases, an indeterminate length of time is required to complete the luxations. The femur in such cases rarely escapes from the acetabulum in less than three or four years after birth ; and surgeons have been thus led to suppose the affection non-congenital.

An essential step towards the reduction of the dislocation, is the division of the retracted muscles, whether actively or passively affected.

CONDITION OF THE MUSCLES AND SOFT PARTS.

The muscles originally concerned in inducing the luxation are actively retracted. Others, passively retracted, merely accommodate themselves to the approximated points of insertion. Their direction is often changed.

Their texture is either fibrous, when tense ; fatty when exempt from traction ; or hypertrophied when tasked with the duties of inefficient muscles.

Muscles primarily retracted, require division. Those passively shortened may be, in certain cases, mechanically extended, but sometimes require division. The fatty tissue opposes no obstacle to the normal position of the part.

The arteries become flexuous and retain their length, but decrease considerably in volume.

The veins increase in number and in size.

The nerves are shortened, probably through the agency of their fibrous sheath ; and their mechanical extension, during treatment, is attended with pain.

The cellular tissue increases in quantity, fills up depressions, and takes the place of the atrophied muscular fibre.

The skin adapts itself to the conformation of the subjacent parts, being often cushioned in depressions, by adipose matter.

The ligaments and capsules, like the muscles, are changed in form, dimensions, and texture. They may be actively retracted as well in congenital dislocation as in other deformity. In ex-

treme adduction of the foot, the internal lateral ligament of the tibio-tarsal articulation and the astragalo-scaphoidean ligament are sometimes reduced to a third or a quarter of their normal length. In the same way the external lateral ligament of the knee offers an obstacle to the correction of internal deviation of this joint. The ligaments are also subject to passive retraction, merely accommodating themselves to their approximated points of insertion.

When extended, they become thinner and longer. Like the muscles they are subject to fatty transformation when in a state of continued repose, though in a less degree. In conditions which produce the fibrous transformation of the muscles, the ligaments tend to become ossified; a condition which is also the occasional effect of rest alone.

The articular capsule of the femur when extended gradually, acquires the form of a double cone united at their summits.

In fine, the ligaments and capsules when retracted, offer invincible obstacles to reduction by unaided mechanical force; and when elongated, they constitute a serious impediment to any efforts to maintain this reduction.

The cavity of the capsular ligament of the head of the femur, has been found to be obliterated in old subjects; a fact upon which has been founded an argument against attempts at reduction. This condition does not exist in young subjects; and is rarely a serious obstacle to reduction until the pa-

tient attains the age of twelve or fourteen years. The communication has been found to exist even in subjects of twenty, twenty-five, and thirty years of age.

Alterations of the articular extremities. The head of the femur, for example, is diminished in size, while its neck becomes shorter and more horizontal. It may be flattened or grooved, by pressure against the edge of the socket, or other neighboring parts.

When no longer lubricated by the synovial fluid, its surface loses its polish, and becomes rough, while the cartilage gives place to bone.

Articular cavities. The cotyloid cavity is especially the seat of alteration. It tends to become at once superficial, and triangular, in a manner corresponding to the triple formation of the os innominatum.

The articular cavities tend to become obliterated, in proportion to their original depth, and the date of the lesion. This is effected in two ways. 1st. By the rising up of the bottom of the socket, which seems to result from the absence of pressure. 2. From the production of a cellular fatty tissue, apparently the hypertrophy and degeneration of the normal tissues of the base of the cavity.

When the luxation is partial, the cavity yields to the continued pressure of the head of the bone in the direction of the force which it exerts.

These conditions may be thus summed up, with reference to the reducibility of the luxation. 1. When the head of the bone has escaped from its

socket, and no new socket has been formed, both the articular extremity and cavity proportionately diminish in size. This circumstance, while it facilitates reduction, impedes subsequent movement. The reduction, however, tends to induce the parts to resume their normal size. 2. If the head of the bone has formed a new socket, it retains much of its original dimensions, a condition which hinders it from entering the atrophied socket, and prevents its reduction.

3. The grooves and other irregularities in the conformation of the articulating extremity, interfere both with reduction and subsequent movement.

4. After reduction, the articular deformities, and the relaxation of the capsules, facilitate the recurrence of luxation.

The changes both of bones and soft parts is gradual and slow, so that though these luxations become after a time irreducible, they are not so at first. Guerin has reduced congenital dislocation of the femur, of ten years' standing, and M. Guillard has reported a similar case of permanent reduction of a scapulo-humeral luxation, in a girl of sixteen years of age.

Congenital Dislocation is not due to a simple arrest of developement of the bony structure. If the bones be examined at an early period after luxation, they are found unchanged.

ALTERATIONS OF PARTS IN THE NEIGHBORHOOD OF LUXATIONS.

New articular cavities are sometimes formed, and sometimes not. They are rarely developed before the age of twelve or fourteen, but the period of their formation varies. In an old woman of seventy-three with double congenital luxation of the hip, one new cavity was formed, while the other side presented merely a slight depression.

With regard to the conditions which aid in establishing the new socket, M. Guerin declares it to be a law that such cavities are formed, only when the capsular ligament is ruptured, and the head of the bone is placed in contact with the bone upon which it lies.

When the new joint is formed, the ruptured capsule contracts firm adhesions, which preclude all chance of displacing the bones, except by unjustifiable violence.

When there is no new joint, the head of the bone is finally bound down by fibrous cords, which require subcutaneous division.

Alterations of the skeleton. These are especially observed near the hip. Contrary to the opinion of Dupuytren, the pelvis often suffers in these cases, as has been shown by M. Sedillot.

When one femur is luxated upwards and outwards, the pelvis of that side is carried upward, backward and outward. The whole pelvis is flat-

tened obliquely, the pubis being carried beyond the median line towards the healthy side.

The os innominatum of the affected side becomes more perpendicular, and that side of the pelvis is elevated.

INDICATIONS FOR REDUCTION.

From examinations of the pathological conformation of the parts, in different stages of lesion, it results, that congenital luxations are reducible in certain conditions; that they are less so in proportion to the degree and long standing of the deformity; that they are wholly irreducible when very old, and principally when accompanied with new articular cavities; and, finally, that the permanence of the reduction is in proportion to its facility.

MEANS OF PREPARING FOR, EFFECTING, AND CONSOLIDATING, REDUCTION IN ALL ARTICULATIONS.

1. Preparatory and continued extension, which counteracts the displacement due to superincumbent weight, and brings into view the retracted muscles.
2. The subcutaneous section of muscles which refuse to yield to extension.
3. Continued extension of the ligaments; and their subcutaneous section if required.
4. The reduction of the luxation.
5. The consecutive treatment; of which the indications are

1. Apparatus of extension to elongate the muscles and ligaments not divided, and to extend those which have been divided.

2. Force so supplied as to maintain the articular surfaces in contact, and to exercise continued pressure upon the part destined to form a new socket.

3. Gradual motion in imitation of the normal movement of the part; to wear away as it were a depression for the articulations, and to establish its functions.

4. An indication derived from the fact that the capsule must be ruptured, and the bones placed in contact before a new articulation can be established.

M. Guerin therefore practices subcutaneous perforation of the capsule, and scarification of the ligaments, to promote an inflammatory action, which may induce their firm adhesion.

In this way M. Guerin reduced the congenital dislocation of the sternal extremity of the clavicle in a girl of thirteen years of age, which had been repeatedly reduced, without success. M. Guerin scarified the capsular ligament, and repeated the operation at the end of ten days. The extremity of the bone was confined in its place, and in a month the ligaments were firmly retracted, and the arm was capable of executing its normal movements without luxation of the clavicle.

RECENT AND CHRONIC DISLOCATIONS.

The tendons not unfrequently form a serious impediment to the reduction of accidental dislocations of long standing, especially of the humerus and olecranon. They have been not unfrequently divided in these cases, by the subcutaneous operation, and the limb has been thus replaced with comparative ease.

The pectoralis major, latissimus dorsi and teres major and minor muscles, have been thus divided for the purpose of reducing a dislocation of the shoulder of long standing.

I have seen M. Berard divide the tendo Achillis, for the purpose of facilitating the reduction of a recently dislocated foot. The foot was easily replaced, and the patient subsequently recovered its use. Several similar cases are reported in the journals by this surgeon, and by other writers.

In the reduction of a dislocation of the foot, of long standing, accompanied with the formation of an artificial tibio tarsal joint, M. Bonnet divided the tibialis posticus, the extensors of the toe, and of the great toe, and finally all the fibrous tissue of new formation.

SECTION OF MUSCLES IN LOCKED JAW.

Certain rare forms of this affection are due to bony anchylosis, for which M. Berard has proposed a section near the condyles analogous to that practised in Barton's operation for anchylosed hip.

The more common form results from muscular contraction. For such cases M. Bonnet[1] proposes the section of the masseter and temporal muscles, as an aid to ordinary mechanical means for separating the teeth. *The masseter* is best divided according to Bonnet, in its superior fifth. Below this point, it adheres to the lower jaw and is covered behind by the parotid gland. The tenotome is entered at the anterior border of the muscle, just below the zygomatic arch, and carried behind it as far as the coronoid process of the lower jaw. The muscle is then divided from within outward.

[1] M. Bonnet effected the division of the masseter muscle, Oct. 16, 1841. It had been performed by Dr. Schmidt of New York, the 8th of the same month.—*Boston Med. and Surg. Jour.*, July, 1842.

The temporal muscle may be divided above or below the arch. It is best divided below, unless, as in old patients, the coronoid process is so long as to impede the progress of the knife. The muscle may be always divided above the arch, but its substance is less tendinous, and the hemorrhage from the deep seated temporal artery is considerable.

In the section *beneath the zygomatic arch*, the tenotome is entered at nearly the same point as for the section of the masseter, and directed towards the tuberosity of the superior maxillary. The blade is then passed backwards, between the external pterygoid and the temporal muscles, until it reaches the articulation; when the muscle is divided from within outwards. The coronoid process is occasionally an insurmountable obstacle to the section in this region.

Above the malar bone the blade is entered just in front of the temporal artery, and carried to the bone, in contact with which it remains until it reaches the posterior part of the malar bone. The edge is then turned outwards and the muscle divided. Both the muscles may be simultaneously divided.

In one case in which M. Bonnet applied these methods, a slight amelioration was obtained. The patient was old, and the affection of long standing.

The operation of Dr. Schmidt was followed by immediate relief in locked-jaw of twelve years standing.

SUBCUTANEOUS SECTION OF THE ORBICULAR MUSCLES.

These muscles have been subcutaneously divided, with good results, for various affections. That of the mouth, for deviation of one of the angles, which assumed, after operation, its normal position.[1] That of the eye, by Cunier, for ectropion. The sphincter of the anus, by Blandin, Brachet, and others, in cases of fissure of the anus.

M. Phillips affirms that the orbicular muscles are not formed of circular, but of straight fibres, obliquely situated, and attached by one extremity to a median line, and by the other to an aponeurotic circle which surrounds them.

This he infers from the irregular form of the mouth in the spasmodic action of its orbicular muscle, and from the fact that, in drawing upon the

[1] Phillips' Tenot. Souscut. p. 204.

fibres, in any direction, the orifice is distorted and a chord instead of an arc is produced by the traction.

The relief obtained by the division of the orbicular muscle of the eye, in the case of ectropion above referred to, seems to confirm this theory.

APPENDIX.

In the treatment of deformity, it is common to take at the outset, a cast in plaster of the distorted region, which may be afterwards compared with a cast taken at a subsequent time. The result of orthopedic treatment is in this way readily appreciated.

In casting entire limbs some little dexterity is requisite. The tendency of the dried or anhydrous sulphate of lime to set, or form a solid hydrate when mixed with water, is well known, and most people are familiar with the general features of the process of casting in plaster. But there are some details connected with manipulation, in casting large masses, and in taking moulds from the living subject, which deserve to be mentioned. I have therefore written out the following description of the process, most of which I obtained, one morning, from the '*mouleur*' attached to Guerin's establishment.

1. No tools are a substitute for the hand, which is in contact with the plaster during the whole process. The only utensils required are a stiff spatula of wood, or better of iron, a bowl, a chisel and mallet.

2. The necessary quantity of plaster must be mixed at once. It is evidently better to exceed than to fall short of the required amount.

3. The most convenient vessel is a basin or common earthen pan with flaring sides. Into this, water at the temperature of about 100 degrees [1] is first poured. The calcined plaster is then taken in large handsful, supported by the open palm and fingers which are slightly separated, and gradually sprinkled into the water by a sort of successive undulating movement of the fingers. In this manner the water attacks each particle as it falls, and hinders the formation of lumps which are afterwards difficult to break up. The powder is equally distributed until it is so heaped up that it begins to appear above the surface. Half a minute is then allowed to elapse to enable the water to penetrate it thoroughly, after which the mass is stirred with the spatula until it assumes, at the end of a minute, a uniform consistence of the density of thick syrup. It is then ready for use.

The plaster is placed in contact with the object, of which a cast is desired, and when hard is removed. It then constitutes a mould into which a fresh quantity of plaster is subsequently poured. The last should present, when withdrawn, a fac-simile of the original.

It is evident that solid objects require a mould of several pieces, which multiply in proportion to the complicated form and unyielding material of the model. Flesh and other soft tissues yield to the projecting angles of the mould; and the number of its pieces is thus considerably diminished; so that it is rare that a human limb or trunk requires a mould of more than two pieces.

[1] Cold water subjects the patient to unnecessary exposure.

The divisions are made by means of a strong thread which is applied to the limb before the plaster is laid on; and being withdrawn by its loose ends when the plaster is half hardened, it cuts its way out and bisects the mould. The position of the string as a general rule is as follows:

1. On the leg, from the superior insertion of the rectus muscle over the patella, along the tibia to the outer side of the great toe, and by the centre of the sole, heel, and ham, to the tuberosity of the ischium. A better division is from the great trochanter to the head of the fibula, centre of the external malleolus, thence on the external edge of the foot to the edge of the little toe, and the end of the great toe; then back to the internal malleolus, the internal condyle of the femur and the superior insertion of the adductor muscles.

2. The arm is divided by a line from the region of the pectoral on the side to the styloid processes of the pronated radius and by the radial edge of the hand and the tips of the fingers to the styloid and coronoid process of the ulna and the region of the deltoid. If the fingers be separated, the string is to be carefully carried to the base of each, upon the edge which separates the palmer and dorsal surfaces.

3. Upon the trunk, the line passes over the back of the neck a little before one shoulder to the great trochanter on one side, and behind the other shoulder to a point just behind the trochanter of the opposite side.

The action of respiration commonly breaks the mould upon the anterior surface of the trunk, and the pieces are to be subsequently put together.

4. The mould of the head requires but two pieces, separated before and behind on the median line, or, which is better, by a line through the vertex passing

before one ear and behind the other. Such an oblique division obviates the difficulty presented by corresponding prominences on opposite sides of the original. They are thus distributed between the two halves of the mould. The hair is covered by an oiled napkin and the ears are plugged with cotton.

The head is commonly included in a cast of the neck; a perpendicular position is necessary. The soft plaster then flows off from the sides of the nose without obstructing respiration. In the horizontal position, quills or paper tubes are adapted to the nostrils.

A perpendicular position is required to display the action of the muscles of the neck or trunk, while the limbs may be cast horizontally. When permanently flexed, the plaster is kept in contact with their inferior surface, by a sort of bed formed by a sheet of stiff paper supported by straw.

As a slight motion breaks the plaster before it is hardened, young children require to be confined during the process.

If a leg for example, is to be cast, the plaster is prepared as before indicated, some of the thinner plaster is then applied with the hand to the external and internal surfaces of the limb, and by means of this the string is made to adhere, care being taken to bring it in contact with the skin at every point. The limb is then gradually covered, and the plaster as it thickens, is applied with the hand till it attains a depth of from one to three inches. The string is withdrawn while the plaster is yet soft, and the mould thus divided is allowed to harden. The mass grows warm; and it is just before its maximum heat, when a fragment pressed between the thumb and finger breaks as if dry and brittle, that it is to be taken off. If the plaster by accident

becomes too hard, so that the string breaks, the mould is to be broken with a chisel and mallet, and the fragments are subsequently united, by a layer of plaster applied to the outside.

In casting the back, the model is seated upon a table and the hairs of the neck being matted together with soft soap, the plaster is applied with the hand to the upper part of the neck and shoulders and allowed to stream down the back. As it attains consistence it adheres to the skin and may be built up.

The interior surface of the mould thus formed is *immediately* painted over with a mixture of soft soap and water, and when saturated, the superfluous soap is removed, and a thin coat of oil applied. If composed of pieces, these are united and the mould is then ready for the cast. Plaster is prepared as before, without delay, poured into the interior, and allowed to set.

At the expiration of fifteen minutes the mould must be broken off in small fragments with a chisel and mallet, and is hence said to be lost, (*stampa persa.*) During this operation the cast is held in the lap, and the blows should be given in the direction of the axis which presents the greatest inertia. The mould is thus readily detached; its entire superior surface being removed before the base is attacked.

If the cast be not immediately made, the mould becomes dry and must be soaked in water before the application of the soap. If the operation be delayed for several days, the plaster of the mould becomes so hard as to be with difficulty broken. If the cast be allowed to remain a few hours in the mould the oil is absorbed and the surfaces are with difficulty detached.

If a duplicate cast be desired, a permanent mould (*stampa buona*) is made upon this first cast, which then

serves as the model. The model is well oiled and plaster is applied in small masses each capable of being detached from its various curves and angles. The first piece is detached and its edges squared with a sharp knife after which it is oiled and replaced to aid in the formation of the next. These fragments are numerous when the model is complicated. Drapery, and the statuettes, which are common in the shops, sometimes require several hundred, which are kept in place by an outer covering or garment (*camisia*) of plaster in large fragments. When dry the mould is heated and saturated with boiled linseed oil at a high temperature. This gives tenacity to the plaster, and presents when cold a polished surface, which needs only to be oiled when a cast is required. The pieces are detached in the inverse order of their formation, and such a mould yields an indefinite number of casts.

REFERENCE TO PLATES.

STRABISMUS.

Fig. 1. Speculum for upper or lower Lid.
" 2. Hook for Conjunctiva.
" 3. Double do. for Sclerotic.
" 4. 'Crotchet-bistouri' of Baudens with porte-sponge.
" 5. Blunt Hook of Dieffenbach.
" 6. Tenotome of Guerin, (see p. 26.)
" 7. Side view of do.
" 13. Snowden's blephareirgon modified.

TENOTOMY.

Fig. 8. Common pointed Tenotome.
" 9. " blunt do.
" 10. Myotome for Dorsal Muscles.
" 11. Front view of do.
" 12. Guerin's Tenotome for Sterno-Cleido-mastoid Muscle.
" 13. Self-acting Speculum for Lids.

CLUB-FOOT.

Equinus.

Fig. 14. Foot-board of Stromeyer. (see p. 107.)
" 15. Scarpa's Boot. (see p. 102.) Sole of do.
" 16. } Graduated Movement.
" 17. }
" 18. }

Varus.

" 19. Contrivance for reducing Varus to Equinus. (see p. 108.)
" 20. Dieffenbach's do. (see p. 109.)

Fig. 21. Little's Apparatus for treatment of Varus.
a. Pivot for the metal leg piece, of which the Movements of flexion and extension are limited by the shoulders *c.* and *b.* of the horizontal screw traversing the collar *c. d.* Fixed metal attachment for toe strap. *d.* Strap to bring down the heel.

" 22. } Duval's apparatus for Varus. *a.* Leg piece governed by a
" 23. } graduated universal joint at *c.* (see fig. 17.)

" 22. Oblique view of do. to show. *b.* a cushioned metal plate of which the posterior edge is advanced against the heel by screws, *a.* working in the plate *c.* *d.* key for perpetual screws.

TORTICOLLIS.

" 24. Minerva of Delacroix modified by Bouvier, (see p. 125.)
a. Metal band for pelvis.
b. Metal upright.
c. Shoulder straps.
d. Head band.
e. Vertical do.
f. Chin strap,
g. Metal upright at back of neck.
l. Pin to regulate its length.
i. Graduated flexion, governed by *g.*
h. Graduated rotation. (see fig. 16.)
m. Joint permitting extension but not flexion.
n. Graduated lateral movement.

" 25. Phillip's Cravat, (see p. 125.)
a. Collar.
b. Metal upright (see fig. 27) capable of being raised or depressed.
c. Back piece, confined by waist strap and shoulder straps.

" 27. Back view of 25.

FALSE ANCHYLOSIS OF KNEE-JOINT.

" 26. Bonnet's Apparatus.
a. Cap for knee.
b. Carriage for foot, drawn upon wheels *b.* towards *d.* by weight or otherwise.

" 28. Duval's Apparatus.

" 30. " "

" 29. Little's Apparatus, (see p. 137.)
a. Extension.
f. Counter extension.
e. Cap for depressing knee.

CONTENTS.

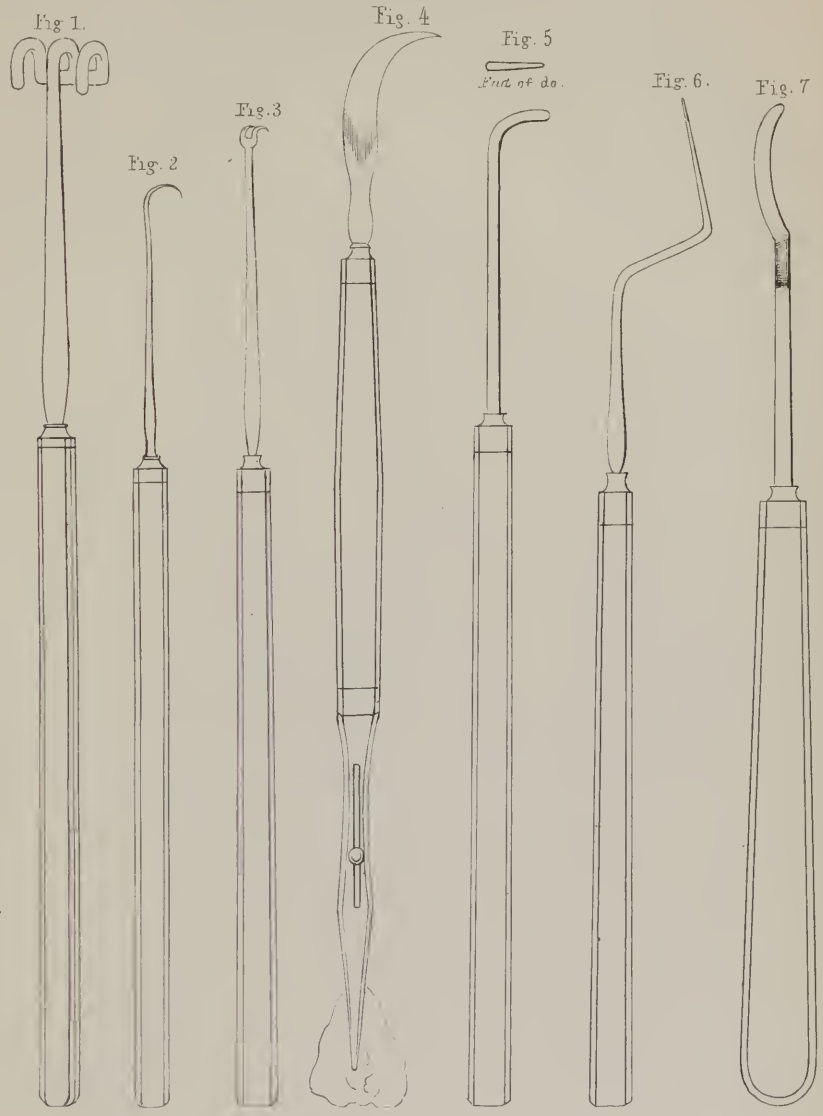
b. Stiff pad for supporting head of tibia by means of
c. Straps.
d. Screw for applying lateral force to head of tibia.

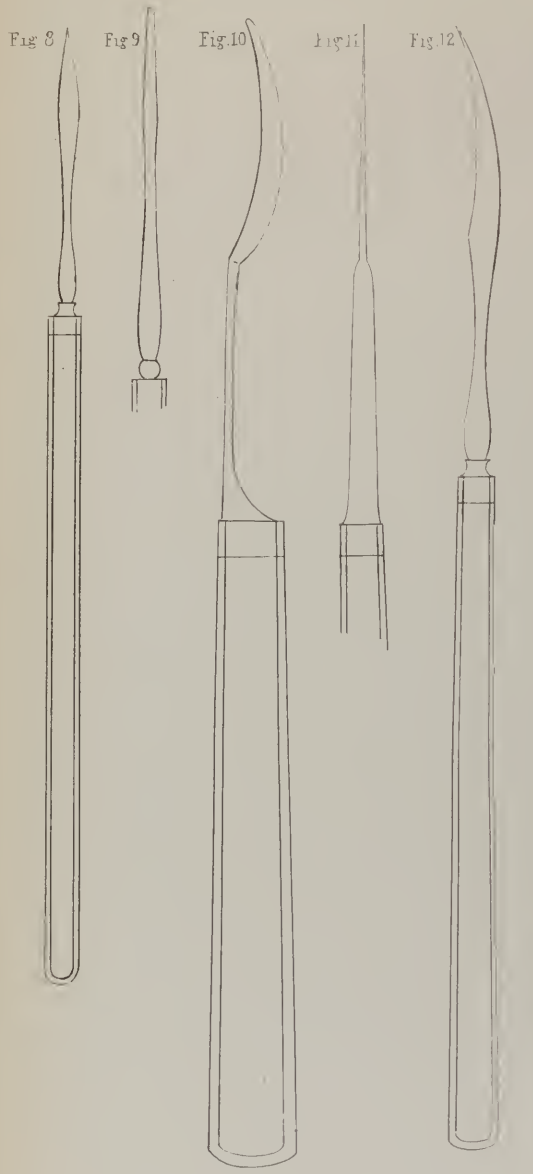
LATERAL CURVATURE OF THE SPINE.

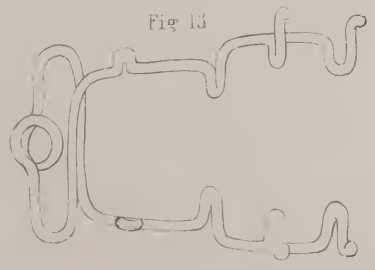
" 31. Guerin's bed for sigmoid extension. (see p. 180—181.)
a. Upper table. (see fig. 34.)
b. Lower table. "
c. Middle Table. "
d. Spring to impart elasticity to
e. The point of counter-extension, supporting the helmet.
f. Slide for the support of *d.*, fig. 34.
g. g. To support the middle table of the bed. (*c.* fig. 34.)
h. h. Lateral centres of flexion.
" 34. Part of the same furnished with its cushions.
d. d. Lateral uprights attached to the upper and middle tables, and capable of being advanced upon the convexity of the spiral curves.
" 32. Bed for parallel extension and simple flexion.
" 33. Helmet with its collar and apparatus for lateral flexion.

Strabismus.

Tenotomy.







Equinus.

Fig. 14.

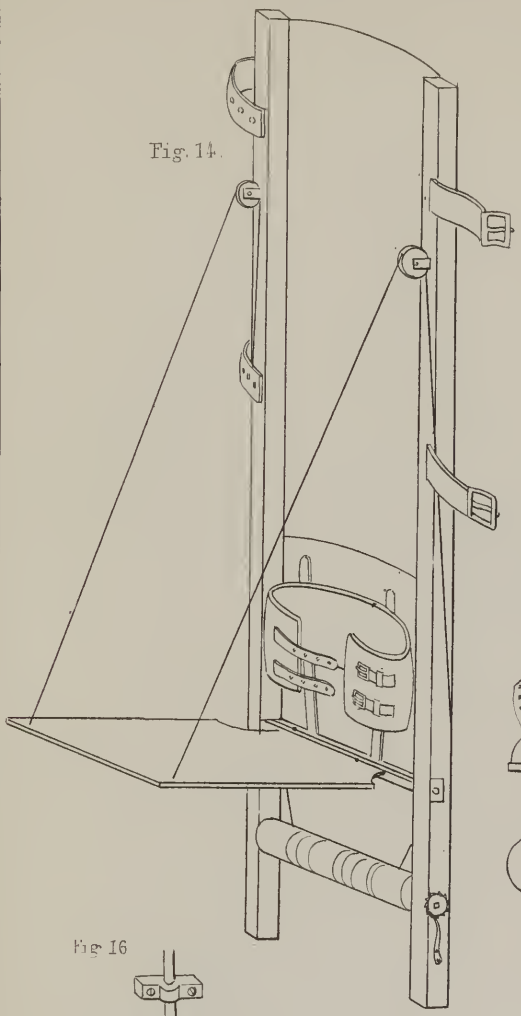


Fig. 15

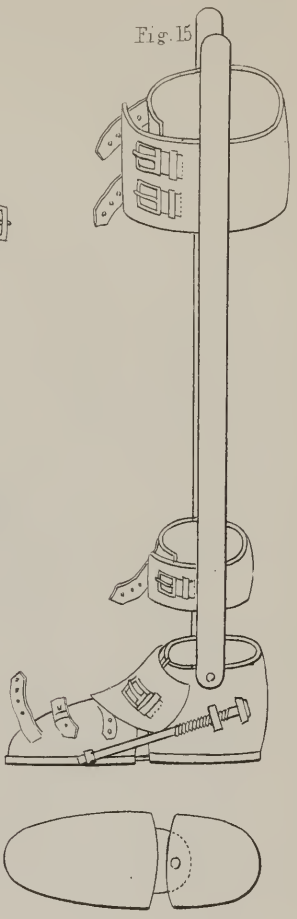


Fig. 16

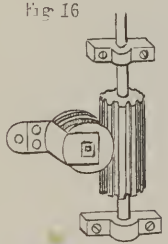


Fig. 17

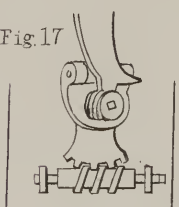
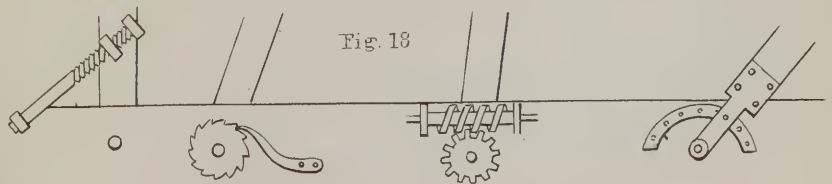


Fig. 18



Varus.

Fig. 19

Fig. 20

Fig. 21.

Fig. 22

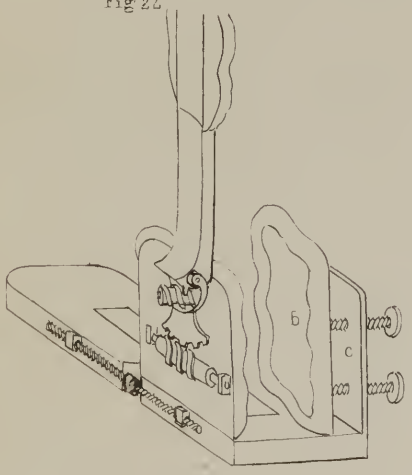
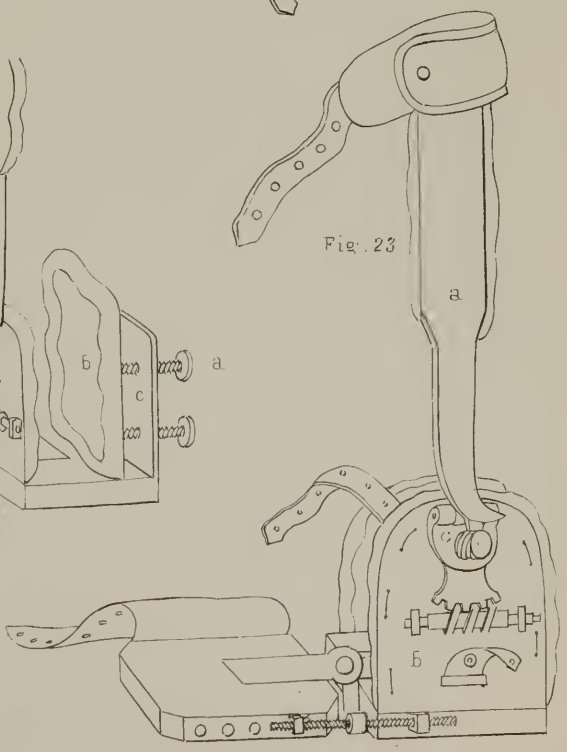


Fig. 23



Torticollis.

Fig 24

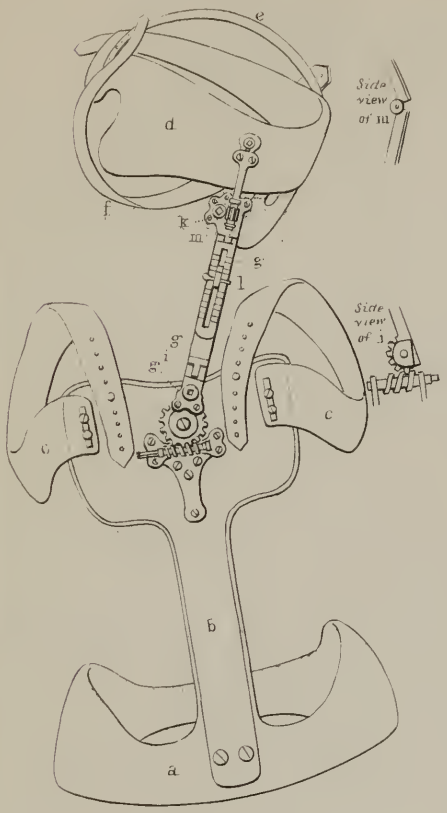


Fig. 25

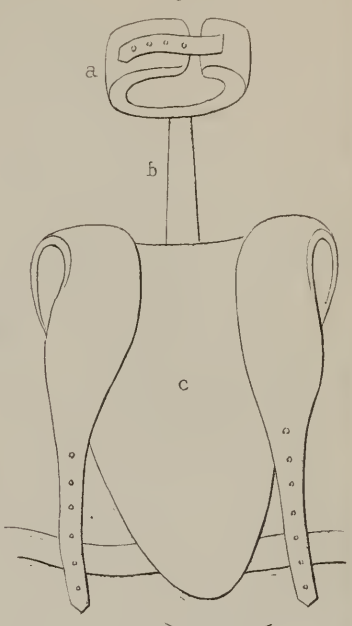


Fig 27

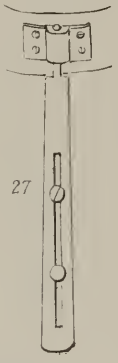
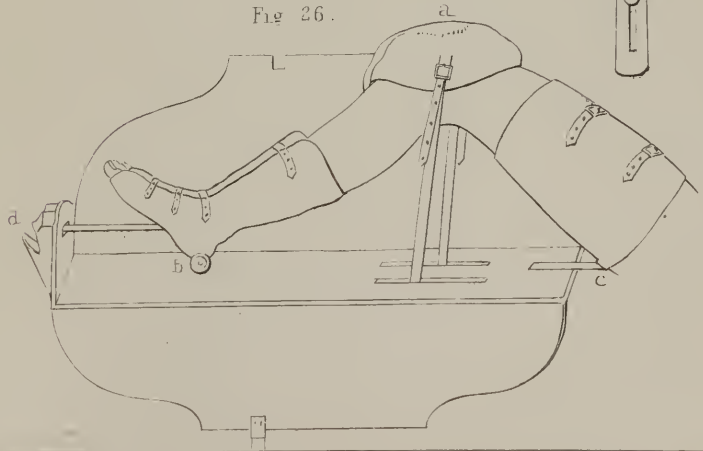


Fig 26.



False Anchylosis of Knee Joint.

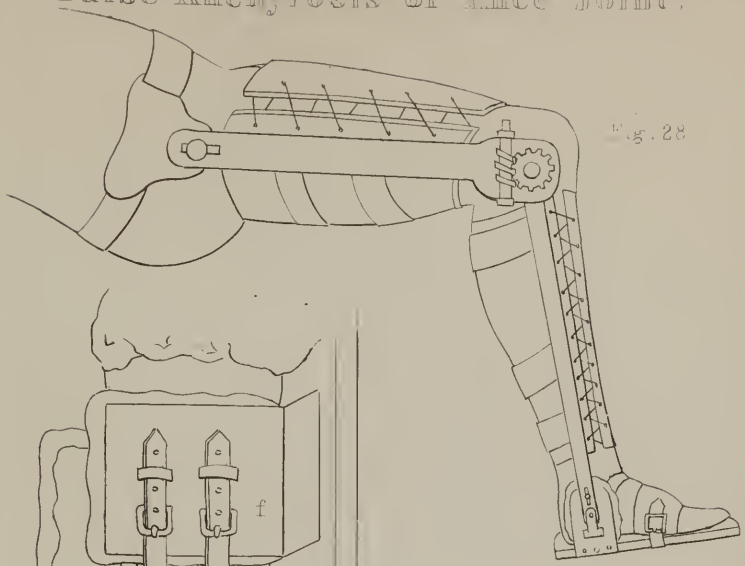


Fig. 28

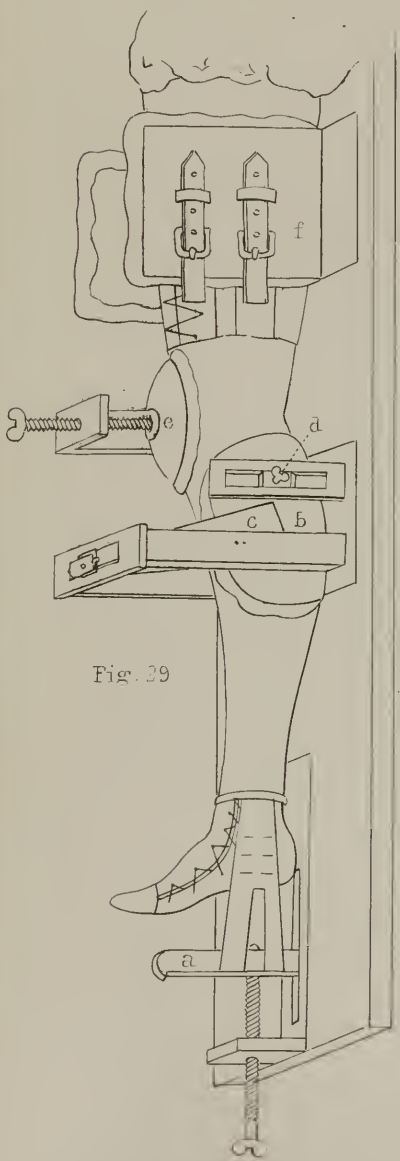


Fig. 29

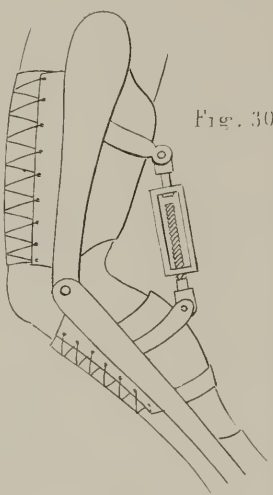


Fig. 30

Fig. 31

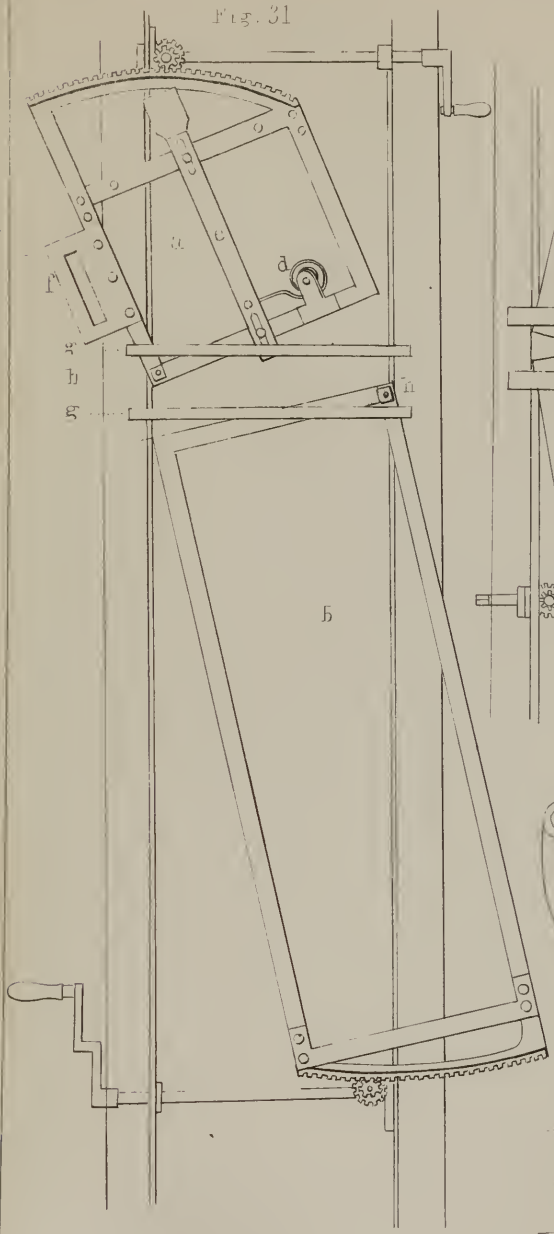
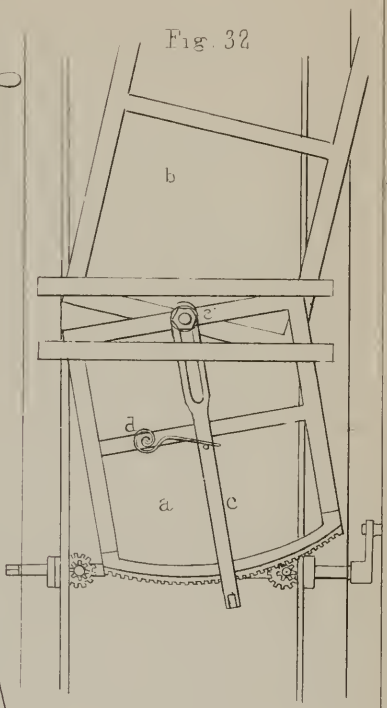


Fig. 32



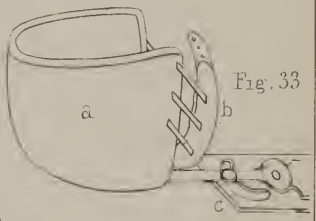


Fig. 33

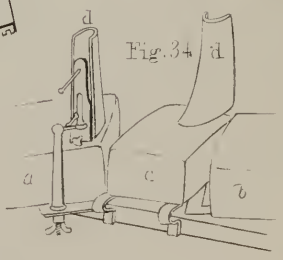


Fig. 34